

Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

1
Ag 855 Sp
92
1909

Issued September 8, 1910.

U. S. DEPARTMENT OF AGRICULTURE.

Report No. 92.



PROGRESS

OF THE

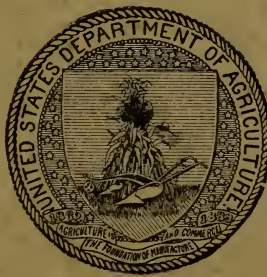
BEET-SUGAR INDUSTRY

IN

THE UNITED STATES

IN

1909.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1910.

Issued September 8, 1910.

U. S. DEPARTMENT OF AGRICULTURE.

Report No. 92.

PROGRESS
OF THE
BEET-SUGAR INDUSTRY
IN
THE UNITED STATES
IN
1909.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1910.

[PUBLIC RESOLUTION NO. 51.]

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That there be printed twelve thousand copies of the report on the progress of the beet-sugar industry in the United States in nineteen hundred and five; one thousand copies for the use of the Senate, three thousand copies for the use of the House of Representatives, and eight thousand copies for the use of the Department of Agriculture, and that the Secretary of Agriculture be authorized to print and distribute annually hereafter eight thousand copies of such annual reports covering the progress of the beet-sugar industry: *Provided,* That the preparation and publication of such annual reports shall be within the discretion of the Secretary of Agriculture.

Approved, June 30, 1906.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., June 11, 1910.

SIR: I transmit herewith the manuscript of the report on the Progress of the Beet-Sugar Industry in the United States in 1909. It consists of the report of the special agent, Mr. Charles F. Saylor; an article by Mr. J. E. W. Tracy, of the Bureau of Plant Industry, entitled "Comparative Tests of Sugar-Beet Varieties;" and a brief abstract from Bureau of Plant Industry Bulletin 181, The Curly-Top of Beets, by Mr. Harry B. Shaw, Assistant Pathologist in Cotton and Truck Diseases and Sugar-Plant Investigations, Bureau of Plant Industry, in cooperation with the Bureau of Entomology.

I recommend that this manuscript be published as Report No. 92 of the Department.

Respectfully,

G. H. POWELL,
Acting Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

	Page.
Report of the special agent, by Charles F. Saylor.....	7
Introduction.....	7
Evolution of the beet-sugar industry.....	8
Methods of cultivation and soil management.....	15
Selecting the beet land.....	15
Preparation of the seed bed.....	16
Seeding.....	18
Cultivation.....	19
Review of conditions and developments, by States.....	20
California.....	21
Colorado.....	25
Idaho.....	29
Michigan.....	31
Utah.....	37
Wisconsin.....	39
States having one factory each.....	40
Statistics of the sugar industry.....	46
Beet-sugar factories in the United States.....	46
Production of sugar beets and beet sugar in the United States.....	49
Acreage of beets planted.....	49
Summary of farm and factory results.....	50
Acreage of beets harvested.....	51
Tonnage of beets produced.....	52
Quality of beets produced.....	53
Production of beet sugar in 1909.....	54
Relative magnitude of the industry in different States.....	54
Extraction of sugar.....	55
Product of sugar per acre and per ton of beets.....	56
Length of campaigns.....	57
The world's production of sugar.....	58
Consumption of sugar in the United States.....	59
Consumption of sugar per capita.....	60
Total consumption of sugar and sources of supply.....	60
Plans and prospects for extending the beet-sugar industry in the United States.....	61
General survey of the situation.....	61
California.....	64
Idaho.....	64
Indiana.....	65
Minnesota.....	65
Montana.....	66

Report of the special agent—Continued.

Plans and prospects for extending the beet-sugar industry in the United States—Continued.	Page.
New Mexico.....	67
Kansas.....	67
Nebraska.....	68
North Dakota.....	68
Ohio.....	69
Texas.....	69
Wisconsin.....	70
Comparative tests of sugar-beet varieties, by J. E. W. Tracy.....	71
The curly-top of beets, by Harry B. Shaw.....	79.
Symptoms.....	79
Symptoms in seed beets.....	80
Only one symptom really characteristic.....	81
Causes of the disease.....	81
Description of the beet leafhopper.....	82
Habitat and host plants.....	83
How leafhoppers induce curly-top.....	83
Curly-top in seed beets.....	84
Affected seed beets almost nonproductive.....	85
Severe outbreaks not frequent in a locality.....	85
Progeny of the diseased seed beets healthy.....	86
Remedies suggested.....	86

ILLUSTRATIONS.

FIG. 1. Diagram showing the standing of sugar-beet varieties tested at each station and at all stations.....	Page.
2. Diagram showing the standing of sugar-beet varieties tested for each year and for all years.....	77
	78

PROGRESS OF THE BEET-SUGAR INDUSTRY IN THE UNITED STATES IN 1909.

REPORT OF THE SPECIAL AGENT.

BY CHARLES F. SAYLOR.

INTRODUCTION.

The beet-sugar industry of the United States passed through a successful year in 1909. Of the 66 factories in existence all were in operation excepting the new plant at Nampa, Idaho. In beet acreage planted and harvested, in total tonnage of beets worked, in amount of sugar produced, in average quality of beets, and in percentage of sugar extracted all previous records were exceeded. The production of beet sugar for the season—512,000 tons—exceeded the highest record by more than 6 per cent, and the record for 1908 by more than 20 per cent.

The closing months of the year were marked by a decided revival of interest in the extension of the industry, due in part to the enactment of the new tariff law. Three new factories are under construction—one at Paulding, Ohio, with a capacity of 700 tons of beets daily, another at Toledo, Ohio, with a capacity of 1,000 tons daily, and another at Scotts Bluff, Nebr., of 1,200 tons capacity. The last is to be equipped with the machinery removed from the dismantled plant at Leavitt, Nebr. One factory built last year at Santa Ana, Cal., made a successful campaign, and the factory at Glendale, Ariz., which had never been successfully operated, made a short campaign with satisfactory results.

Progress was made in the introduction of improved implements for the beet fields. We are approaching a lower cost and better system of cultivation and harvesting. The gang plow and the traction engine are more generally used in breaking up the land and in harvesting and delivering the beets. The traction engine will play an important part in the future of this industry, especially in the mountain and coast States where the lands are in large tracts and labor is scarce.

As the years pass the labor supply becomes greater. I heard of less difficulty on this score than during any previous year. There is considerable comment on the gradual rise in the wage scale. We are overcoming this drawback to a considerable extent in the sugar industry by new devices which diminish the amount of hand labor. While wages are increasing in this country the same is true of other sugar-producing countries, notably Cuba. Wages in that island have more than doubled in the last ten years. The Hawaiian Islands may be used to illustrate conditions affecting tropical sugar production. Ten years ago laborers imported into those islands received on the plantations from \$12 to \$15 a month. They now receive double that amount, when we include as part of the wages the cost of living, which is assumed by planters. The planters' organization of those islands has searched the earth to secure a supply of cheap labor in order to keep down the cost of sugar production. It may be said that a large part of the cost of sugar production is the cost of labor. The Hawaiian sugar planters have imported Japanese, Russians, Mennonites, and Filipinos. Nevertheless the wage scale gradually rises. The same is true of Porto Rico.

A comparison of the price of sugar with that of other food products is suggestive. In the general public agitation concerning the cost of food products no mention is made of sugar. The price of sugar to the consumer has remained practically stationary for the last ten years. In that time prices of many things have doubled, and all have materially advanced. As the cost of labor enters largely into the cost of sugar production, this industry must have shared with others the disadvantages of a rising scale of wages. The fact is that wages on the farm have increased more rapidly than in the cities. Nevertheless the sugar industry has been able to offer the consumer an important article of food at practically the same price for a considerable number of years.

EVOLUTION OF THE BEET-SUGAR INDUSTRY.

The sugar industry is rapidly assuming great importance in this country. No manufacturing industry so intimately associated with and dependent upon agriculture has ever shown such wonderful development, such far-reaching influence in the stimulation and upbuilding of the whole system of agriculture.

In Europe, where the sugar industry has reached its greatest development, and in this country, where it is fast assuming great importance, its status well illustrates the old saying: "The child is father to the man." In Germany, France, Austria-Hungary, and Russia, in districts where sugar beets are the principal crop, it is the basic feature of agricultural husbandry. It governs the plans of

the farmer and enters into the formative schemes of all local enterprise and the hopes of family prosperity.

It has done much to improve agriculture, both in Europe and in this country. In Europe the production of sugar beets has been helpful to rotation of crops, fertilization, and improvement of lands. There are large areas known as the sugar districts. Of course these do not comprise the entire agricultural lands of any of the countries. The parts where sugar beets are grown, however, cover a considerable portion of country throughout each of them. Here the beet crop is recognized as the principal one, and the plans of the farmers are based upon the successful production of beets. Their work is superior to ours, especially in methods of tilth, rotation, and fertilization. As the farms are very much smaller and the population is denser than ours, it becomes necessary that the land be brought to its highest productive power to sustain the population. It is much easier to succeed with intensive farming on small tracts.

The supply of labor is always an important factor in sugar-beet growing. In the European sugar-beet districts there is nothing to hamper or bias production of this principal crop. The people are essentially rural and industrious. They come down through a line of ancestry devoted to rural life and agricultural pursuits. They all work in the fields, from the small children to the heads of families. They grow their labor supply with their beets. There is nothing transient in their plans and aspirations. They are small farmers and hard-working ones. As a rule they are not turned aside by the glitter of city life, opportunities of trade, and other general business activities. They have not the progressive, restless spirit of our people. It is quite common for an American to wind up a successful career at the top, who may have started at the bottom, and followed many a path in the humbler walks of life as a farmer, teacher, merchant, manufacturer, politician, and speculator. Our system may be commended for the opportunities it offers the individual, but not for the advantages it brings to our farmers in the maintenance of a competent labor supply. With their small farms, supply of labor, and habits of settled industry, the farmers of Europe may be said to possess an advantage favorable to sugar-beet production.

It is necessary to discuss European methods and their results in order to derive a proper system of beet culture for our own fields. Our system will never be the same as those of France and Germany, but a study of their methods should nevertheless prove helpful to us. In this country we need to give more attention to cultivation, rotation, and fertilization, not only in the growing of sugar beets, but in all agricultural operations. Through the occupation of the virgin soils of a new continent we have accomplished much with little effort.

Vast areas of cheap lands have been opened up as the tide of immigration has flowed from east to west. Corn, wheat, oats, tobacco, flax, and root crops have been planted without much regard to system, rotation, or fertilization. The virgin fertility of our soil has filled the granaries of our farmers. Their stock has been turned loose on the prairies, to be grazed without care or expense. Our farmers have become prosperous without knowing how or why.

But the public lands suitable to this kind of treatment have passed away. They have been cut up into farms. However patriotic it may be to proclaim the importance and development of agriculture in this country, it must be said that we are in our agricultural infancy. We are just beginning to see the dawn of future conditions and possibilities.

In our Eastern, Middle, and Mississippi Valley States we have nearly reached the limit of productive possibilities with our present methods. Something must be done to bring these lands to a higher state of efficiency. Overworked and poorly manipulated lands must be reclaimed, vitalized, and maintained at their highest yield. To accomplish this, we need systematic, organized effort. The highly organized beet-sugar industry ought to be a great aid to agriculture at this stage of our development. Most of the territory of the States north of the fortieth parallel has favorable conditions for this industry, and practically all of the irrigable lands west of the one hundredth meridian are adapted to sugar production. Beet-sugar factories are now located in many parts of both these regions. They are demonstrating clearly every year the advantages of more effective methods.

The beet-sugar industry induces investigation and experimentation and raises the standard of farming. In several States the agricultural colleges have special courses devoted to beet-sugar production. Such courses are now given in the colleges of Michigan, Wisconsin, Colorado, Utah, and California. Practically all of the experiment stations in the Northern and Coast States have investigated the subject of beet production. The National Department of Agriculture has several experts who give their whole time to investigations relating to the beet-sugar industry. It throws around this industry its fostering influence.

Farm papers and other periodicals devote large space to the facts and needs of the beet-sugar industry. Local farm clubs and farmers' institutes give space on their programmes to discussion of matters pertaining to this industry.

It has been my pleasure for a number of years to be a member of two great national organizations that have been very helpful in the upbuilding of agriculture. These are known as the Trans-Mississippi Commercial Congress and the National Irrigation Congress. The first deals with the interests, resources, commercial growth, and

prosperity of all the States and Territories west of the Mississippi River. The second deals with the same territory, but confines its attention to the problems of reclamation and production through irrigation. It deals with the installation of irrigation projects and the development of irrigation possibilities. At every session of these two bodies for thirteen years agriculture has been the principal theme, and the beet-sugar industry one of the principal topics for discussion.

Every sugar factory has what is known as an "agriculturist," who is aided by a corps of assistants. These are selected on account of their special training and knowledge of agricultural subjects. These are the men who advise the farmers as to proper methods in growing sugar beets, as well as methods and practices best adapted to all crops. Sugar-beet production is so intimately related to everything pertaining to farm activity that their work must keep them in constant association with the farmers and their laborers. The results of their work form a constant education and extension course in agriculture—an education that must and does elevate the standards of the farmer.

Not alone on its past achievements and present status is this industry to be judged. Its history has been one of gradual improvement. During the comparatively short period of its existence in America its evolution has been accompanied by improvement of farm methods and implements and factory methods and equipment. At the beginning of the manufacture of sugar from beets in Europe their content was about 7 per cent and their purity from 65 to 70. From such beets but a small amount of sugar can be extracted. The amount of sugar in the beet is small to begin with, and the large amount of impurities, indicated by the low purity, materially interferes with the extraction of the sugar contained. It has been the business of the scientist to raise these two standards. To-day the average sugar content of the beets of Europe is from 15 to 18 per cent and the extraction of sugar is about 13 per cent. In this country the sugar content of beets is from 13 to 20 per cent. In some places the average is over 19 throughout the sugar campaign, with purity averaging from 80 to 90 and extraction from 12 to 15½ per cent.

The losses of sugar in the manufacturing process were originally very great. Considerable improvement has been made in this respect, partly through producing beets of better quality and partly through the introduction of more modern and effective machinery and methods in the sugar mills. Such improvements reduce the cost of manufacturing the product.

There are many things under investigation with a view to still further improvement of both the agricultural and the manufacturing phases of the industry. Some of them are important and far-reaching in results. The losses occurring in the sugar factory are due to some of the sugar passing off with the cossettes. Another portion

is finally retained in the waste molasses, further extraction being impossible on account of the interference of certain salts and impurities. Some of these impurities are a part of the constituent elements of the beet and some are introduced into the juices in the process of manufacturing sugar.

The experts of the factory and the farm are working assiduously for the needed improvement. It is within the range of possibility that the farmer may so materially improve the sugar content and purity of the beets and increase the yield of the crop that 1 acre of beets in the future will produce twice the amount of sugar produced at present.

The average yield of beets in Germany is a little over 13 tons per acre; in the rest of Europe a little less. In this country the average yield is nearly 10 tons. Some of our older factory districts secure an average yield of beets equal to that of Germany. Let us compare our present yield with the ideal yield. The most usual width between rows in beet fields is 18 inches and the beets are 8 inches apart in the rows. The ideal size of beet is 2 pounds. Beets are often much smaller or larger than this. Often beets are delivered to the factory which weigh only half a pound, and sometimes beets are delivered and worked which weigh 5 pounds; but the ideal is 2 pounds. In the case of the ideal acre of beets, with rows 18 inches apart and beets 8 inches apart in the row, with a complete stand and every beet growing to a size of 2 pounds, an acre will yield 43.3 tons. While it is improbable that this ideal acre of sugar beets will ever be produced, on account of the improbability of having a perfect stand, it seems possible that this tonnage can be produced, because the beets may be sufficient in size or weight to compensate for the shortage in numbers.

There is a vast difference between the present actual average tonnage and this ideal or possible yield. The difference is more than 33 tons per acre. This difference of 33 tons between actual and ideal constitutes the farmer's leeway for improvement. That he can increase his actual yield to overcome a considerable part of this difference goes without saying. The more he reduces it the more will he have performed his part.

In the markets of the world there has been a constant rivalry between the producers of sugar from cane and from beets. This contest has been vigorous and prolonged. It has been a strife for commercial supremacy between the luxuriant conditions of growth and semicivilized poorly paid labor of the Tropics on the one side and the highly developed agricultural lands and high-priced labor of the central temperate zone on the other. It is largely a contest between intelligence and ignorance, the latter reenforced with especially favorable natural conditions.

The progress of methods on the farm and in the factory in the past has considerably more than doubled the amount of sugar produced on an acre of land. It appears possible through further development along these lines to double the present results in the United States, thus greatly reducing the cost of producing sugar.

There are many other things that will greatly increase the results of the beet-sugar factory. Some of these will require years for maturity. I may cite, for instance, the single-germ seed, the improvement of farm implements and factory machinery, and knowledge and use of the by-products of the sugar factory.

The production of a race of single-germ beet balls, as a feature affecting the beet-sugar industry, is purely American. In all the past application of science and study given by scientists of Europe this has not been attempted. In this country it is being attempted through selection. Each beet ball contains from one to six germs, and it is possible that each of these germs may produce a plantlet. In order to secure a stand of beets about six times as much seed as necessary must be planted. This would be true if each ball produced one plant. It becomes necessary to thin out the surplus plants, simply leaving plants standing in the row at the proper space. If the ball producing the particular plant left standing has only one germ, in thinning we have but one plantlet to contend with. In case the ball produces several plants, these intertwine in the soil, and considerable labor is necessary in extracting the surplus plants. Not only is extra labor required but the rootlets of the plant retained will be more or less broken. This temporarily disturbs the growth and vigor of the plant. This is its tender stage, and if we could relieve it from this disturbance we would contribute much to its betterment. The cost of thinning the beets on account of the surplus plants is considerable. It is the working theory that a plantlet produced by a single-germ beet ball will be more vigorous. It will have a natural vigor that comes from better nourishment of the mother seed, as it does not have to divide its food supply with other plantlets. When the surplus beets are removed it is left firm and undisturbed in the soil. This work of attempting to produce a single-germ beet ball has been systematically undertaken by the Bureau of Plant Industry, U. S. Department of Agriculture. By inspection nothing but single-germ seeds are selected to produce the "mother beets." These beets are planted, and from the resulting crop of seed nothing but single-germ balls are selected. This work will be continuous from year to year until such time as the habit of producing single-germ seed is thoroughly fixed in this new race of beets. It will take some years to accomplish this. Enough has already been done to indicate ultimate success.

Work on the farm from the beginning of the industry has been largely a matter of hand labor, laborious and expensive. In Europe to-day most of the cultivation in the fields consists in hand hoeing. Farmers there are slow about changing their methods or devising new ones. With its introduction into the United States a revolution in farm implements in the beet field is rapidly taking place. We have introduced less cumbersome and more effective implements for seeding and horse cultivation; we also make more use of the harrow and the roller.

When the industry came to us we adopted the system of harvesting then in vogue, using a plow to cut off the beets and to loosen the beets by the aid of lifting prongs or a share. The rest of the work was done by hand. Beets were "topped" by a person passing along the row, lifting the beet from the soil, and clipping off the crown and leaves with a long knife. They were thrown into piles and then into the wagon for delivery to the factory. Considerable study has been given to improving this method. Harvesters have been devised for lifting the beets, topping them, removing the larger portion of the dirt, and elevating them into a wagon for delivery to the factory. These machines are not now in general use, but their use is increasing. Different devices of this kind have proven their efficiency. It is apparent that they will be more generally used in the near future. It costs from \$6 to \$8 an acre to harvest and deliver beets 5 or 6 miles. One of the principal items of cost is this old hand method of harvesting. Under this new system the cost would be materially reduced.

Steam and electric power are coming actively into use in the sugar-factory districts. An ordinary beet wagon, propelled by four or six horses, will deliver to the factory over ordinary roads from 4 to 5 tons of beets. In a number of places traction engines are brought into use, very much reducing the cost of delivery. A train is made up of a number of loaded beet wagons and hauled by one of these engines to the factory. Traction engines are now more commonly used for plowing up the land. Gang plows are used and in some instances they turn over as much as 50 acres per day. It appears probable that eventually traction engines will be used extensively to propel beet harvesters.

Great improvement has been made in the sugar factories themselves. New devices have been introduced to shorten the process and conserve energy. Modern factories are now built fireproof of the best material—stone, brick, cement, and steel.

A larger use of the by-products resulting from the beet-sugar industry is one of its principal hopes. We are in our infancy also in this regard. Europe has worked out this problem. In Germany, France, and to some extent in Russia and Austria, alcohol is pro-

duced extensively from beets and the by-products of the mills. Their factories are equipped with special drying plants where the pulp and sometimes the molasses are utilized in the preparation of stock food.

Only about a dozen factories in this country have installed drying plants. With our great stock-feeding interests we should better appreciate the value of these by-products. Considerable of the pulp produced in this country is still thrown away. Most of the waste lime is treated in the same manner.

It must be evident that in the improvement of methods and appliances used on farms and in factories lies a great opportunity for the future growth of the beet-sugar industry.

METHODS OF CULTIVATION AND SOIL MANAGEMENT.

I consider it indispensable in annual reports of this kind to discuss methods of cultivation and soil management. I endeavor to add each year anything new pertaining to the best methods and practices on the farms devoted to beet culture. The demand for my reports is based more on this feature than on any other.

My investigations, taking me as they do into all parts of the United States, bring me into contact with the methods and practices as applied. I have been careful to observe the poor, the indifferent, and the good, and I have endeavored to note the consequences.

SELECTING THE BEET LAND.

Beets are a vigorous crop. Lands that grow them must be fertile, easily tillable, and as free as possible from stones and débris of previous crops. Often inferior lands have been selected, lands that were worn-out, sour, poorly drained, subject to overflow, or had some other defect. On such land a crop of small grain might be planted and failure would not result in serious disaster; but with sugar beets it is different. The seed, preparation of the land, and cultivation of a crop cost from \$30 to \$45 per acre. The loss of a beet crop must be taken seriously. If the land is poor in quality, or from other defects the yield is low, the farmer is out of pocket. In a humid section where rainfall is depended on, the land must produce at least 6 tons per acre to defray the actual expenses. Profits can not be anticipated below these figures. It is evident that poor land is out of the question. Beet growing on them should never be attempted. The farmer should select the best, or keep out of the business. The same is true where irrigation is practiced.

The previous crop will have much to do with the right selection of beet land. They succeed well on stubble land and better still following alfalfa or clover. Corn land is good, but the expense of removing

the stalks and stubs is a serious obstacle. In Germany and France cycles of rotation are definitely planned. The crop to be followed by beets is determined four or five years in advance. Often beets follow themselves to good advantage, producing a second crop on the land before changing to something else, but as a rule this is not to be recommended. I believe some cultivated crop should generally precede beets rather than small grain on account of the stirring which land receives the previous year.

PREPARATION OF THE SEED BED.

Preparation of the seed bed comprehends the stirring, disking, pulverizing, and working of the soil preparatory to planting. The land is usually turned over with an ordinary stirring plow. Sometimes a traction gang plow is used. The depth to which the land should be stirred depends on several things—mechanical condition of the soil and subsoil, depth to which it has been previously stirred; and whether it will receive one or two stirrings before planting. In general it is good practice to stir the land as deep as possible, but it often happens that cultivated lands have never been stirred deeper than 3 or 4 inches. In such cases it is not desirable to increase the depth more than $1\frac{1}{2}$ to 2 inches the first year. Increase must be brought about gradually.

The need for deep plowing is largely for mechanical reasons. The body of the sugar beet, or that portion of it harvested, is about a foot in length. The beet should be completely embedded in the earth, and this result is favored by a loose soil. If the soil is hard a portion of the beet is liable to be forced considerably above the surface, and this projecting portion must be clipped off at the harvest because it contains too many impurities. Farmers are directed to clip the beet at the sun line. The lateral rootlets of the beet which gather plant food should have loose mellow earth to grow in. It is recommended that the land should be broken some time in advance of planting. In the Eastern and Middle States when convenient it should be fall plowed, and in the spring it should rest a while to allow weed and grass seeds to germinate. It should then be stirred and harrowed. This eliminates much of the crop of weeds and grass which would pester the farmer further along.

After the ground has been turned over the surface is often in a lumpy condition and should be disked until it is well pulverized. The spike harrow should then be applied to complete the work. The surface, if possible, should be as fine and mellow as a garden or flower bed. Often the roller is necessary to accomplish this. If the soil be too loose the roller will compact it and make it more firm, but the harrow should follow immediately to conserve the moisture. When the seeds are planted they require to be firmly embedded in soft

earth. To accomplish this, it is often necessary to run the roller over the surface after planting. If the surface be left too smooth, the wind will carry along the loose grains of sand, cutting off the tender beet plantlets. In such cases planking may be preferable to rolling.

Under preparation of the seed bed we may also include the fertilization of the soil. Farmers at present are giving this matter very little consideration. Very little commercial fertilizers are used on the beet fields in this country, partly because the farmers do not know what to apply. The experiment station and the factory agriculturist are testing out the needs of our soils, but this is a problem that will require some years for solution. At present the growers are depending largely on barnyard manure, which should, as a rule, be applied to the land the year before it is planted to beets. In some factory districts dried blood from our slaughterhouses has been tried. Green manuring is rapidly gaining in favor, especially in districts producing alfalfa. It is found that excellent results come from following alfalfa with beets. The benefit is twofold: (1) It furnishes the nitrogen plant food; (2) the roots of the alfalfa penetrate the soil to a considerable depth, sometimes 15 feet or more. When alfalfa land is turned over for beet growing, the roots of the alfalfa decay, leaving miniature hair-like tubes which facilitate the passage of moisture to and from the lower depths of the subsoil.

Many of our soils are sour and can be improved materially by the application of soluble lime. All our sugar factories have considerable quantities of waste lime refuse. It requires from 9 to 10 per cent of lime rock to clarify the juice of a ton of beets. This lime is burned in kilns, mixed with water, and applied as milk of lime to the juice extracted from the beet. The lime is then extracted or strained off from the juice and becomes a waste product. This waste lime contains much of the salts originally in the juice of the beets. Every sugar factory has immense piles of it. They have been offering it to the farmers free for application on their lands. In many cases good results have been obtained in this manner. It is a question that deserves more attention and study. It should be known under what conditions this lime should be applied to the soil. It is evident that it need not be applied in all cases, but in many.

Moisture has considerable to do with the preparation of the seed bed. In irrigation districts planting may occur after a long dry spell, the same as in rainfall districts. In cases of this kind irrigation water may be applied just before planting or soon after, but the practice is only recommended when the soil is excessively dry. This practice is known as "irrigating up" the beets. It is not desirable, but sometimes must be resorted to. Moisture from rainfall is, of

course, not under our control. All the farmer can do is to exercise good judgment in selecting the time for planting. If he is ready, he can often take advantage of rain conditions that will aid his crops materially.

SEEDING.

Seeding is a simple process accomplished with a special drill or seeder, which sows four rows at a time. The seed should be planted to a depth varying from three-fourths of an inch to 2 inches, according to conditions of soil, moisture, etc. If the soil is in good moist condition shallow planting is recommended. If the surface is dry the seed should be planted deeper. From 15 to 20 pounds of seed per acre are required, depending upon the climatic and soil condition and the quality of the seed. It should be the aim to plant the seed in such a way as to have moist mellow soil in contact with the seeds. This prevents their rapid drying out by evaporation and it affords means of attracting moisture from the soil. Where the seeds are surrounded by small clods with open spaces between there is very little prospect that germination will take place.

The farmers are wholly dependent upon the factories for their seed supply. The quality of seed is of as much importance to the factory as it is to the farmer. The character of the seed governs largely the supply of beets for its campaign. It also governs to a great extent the quality—the sugar content and purity of the beets. This quality is very important to every sugar factory. Upon it depends the amount of sugar secured from the beets and the cost of securing it. Beet seed is imported in large quantities every year by the sugar factories and tested for germination. No farmer could afford to import his seed. If he did and they proved poor, the transaction would be so small that he could not afford to make the seller responsible. He would simply have poor seed and that is all. The seller appreciates that the factories, buying in large quantities, will hold him responsible. I have known serious consequences extending over a whole factory district to result from inferior seed secured from an irresponsible source.

The time to plant varies in different parts of the country. In the Mississippi Valley and Eastern States it is from the 1st of April to the 1st of June, the exact time depending upon prevalent conditions. In Colorado, Utah, Montana, and Idaho planting may possibly begin two or three weeks earlier. In California planting may be done from the middle of November to June 1. Experience has greatly changed the date of planting in California. In one section of the State seeding for the crop of 1910 was done about two months earlier than ever before. All parts of the State now plant considerably earlier than formerly. These changes were induced by experience, moisture being the governing factor. Formerly most of the beets were grown

in California without irrigation. Gradually irrigation facilities have been introduced mainly through the development of artesian water, both from flowing wells and those requiring pumps. New irrigation projects using water from running streams have been introduced. Still the larger portion of the beets produced in California are from lands not irrigated. From 10 to 16 inches of moisture usually falls in southern California from December to March. Beets planted early receive the benefit of this moisture during their early growing period. When the dry season comes they have developed considerably, the tap roots having gone down to sufficient extent to support the beets as the water level recedes in the soil. Beets may be planted in Arizona for the factory at Glendale early enough to mature in April or May, when the sugar-making campaign may begin.

CULTIVATION.

As a matter of fact, cultivation begins with the preparation of the seed bed. Proper cultivation given the soil prior to seeding is about as effective as that which follows. Much depends on the pulverization and texture of the soil. Cultivation is very much facilitated when the soil is properly prepared for it.

After planting, beets are often harrowed before they are up. They should be gone over with the horse cultivator soon after the plants come through the ground or when it is considered safe to work among them. Here is where hand work begins and it should be applied vigilantly. Grass and weeds will start up with the beets. It is much easier to destroy them when they are young than further along. As much hand hoeing should be applied as the necessities of the case require. The same is true of horse cultivation. As a rule, the beet fields should be gone over with the cultivator from three to five times, and with the hand hoe two or three times. When the beet shows four leaves or a little before, they should be blocked and thinned. Properly done, this is one of the best hand cultivations the beets receive. The cultivator and hoe should be alternately used until the beets are too large for horse cultivation without injuring them. Hand laborers should continue to go over the beet field, pulling the weeds and grass that may have persisted. At the harvest they should present as nearly as possible a clean condition absolutely free from grass and weeds. The grass and weeds are deleterious in two ways: (1) They take the moisture and plant food from the beets; and (2) they prevent by their presence the free circulation of the air and penetration of the sun's rays. Their elimination is the best thing the farmer can do toward elaborating the sugar in the beets. The three agents producing and storing sugar in the cells of the beet are water, sunshine, and air. Sugar forms no part of the plant food emanating from the soil. It comes entirely from the atmosphere. The necessity of clean

beet fields is evident. A properly cultivated field of beets freed from grass and weeds may be much earlier harvested.

Irrigation is a very important feature in the cultivation of beets. The application of water may be detrimental or exceedingly helpful. It should not be applied until necessity absolutely requires. Beets should get along with the rain they receive until injury is imminent. They may show indications of wilting or drooping and still not require irrigation. As long as they recover readily at night they are in no danger. Nature provides a tendency in plants and animals to self-sustenance. If they are aided in this respect they grow dependent upon such help. Sugar beets are not exceptions to this rule. If left alone, as the water level recedes in the soil they send down their tap roots and laterals to secure moisture. If this is furnished them by irrigation they will cease this effort to a considerable extent and depend upon the artificial supply. Then, if excessively dry weather occurs, such beets are in no condition to cope with it, as the roots do not penetrate to sufficient depth to draw up the water from the soil. An overirrigated beet is liable to be bunchy, not of proper form, not to have the qualities of a shapely one. The proper application of irrigation is an art which can not be acquired from set rules or directions; yet it is very important in the production of sugar beets.

Often beet fields are subjected to a beating rain followed by a hot sun which incrusts and bakes the ground. This may occur about the time the plants are ready to come up. In such cases the grower is often in doubt as to what to do. I investigated a case of this kind. The condition I have described prevailed throughout the whole beet-growing area of a large sugar factory. It was an unusual case. The agriculturist was at a loss to know what advice to give the growers. The beets had germinated, had reached the surface, and were attempting to penetrate it, but it seemed impossible for them to do so unaided. On removing the crust they were discovered still growing but pale and weak and turning back, forced by the hard surface. They were yellow and evidently in a precarious state. Some of the farmers went so far as to plow up the land and plant it to corn. The agriculturist finally advised a thorough harrowing to break up the crust. Some of the plants were destroyed, but enough remained to make a good stand, and eventually most of the fields gave an excellent yield of beets.

A proper method of cultivation is acquired by progressive training such as is giving excellent results in our old factory districts.

REVIEW OF CONDITIONS AND DEVELOPMENTS, BY STATES.

In the following pages the status of the beet-sugar industry in the several producing States is reported, the climatic conditions affecting the production of beet crops during the season of 1909 are reviewed, and other matters affecting the industry are noted.

CALIFORNIA.

California is a fertile field for the study of conditions, benefits, and growth of the beet-sugar industry. It was the cradle of beet-sugar production in the United States. Here is located the oldest continuously successful plant in this country, the plant established at Alvarado, Cal., in 1879. The beet-sugar plants of to-day, however, are not very similar to this original. Even at Alvarado the industry shows a marked evolution, the plant being now a modern, up-to-date concern.

In this State as elsewhere the beet-sugar industry has encountered trying experiences. Originally the moisture for the crop was from rainfall. For a period the State experienced droughts, which tended to discourage the industry. It came to a standstill during this period, and no new factories were built. But in the last six or seven years climatic conditions have been more favorable, and the industry has enjoyed a new period of growth. Several of the older plants have been enlarged, and the districts are producing a higher tonnage per acre and a better quality of beets. The manufacturing companies are able more readily to secure larger acreages.

In California, in order to protect themselves against shortage of beet supplies, some of the beet-sugar companies have either bought or rented lands for the growing of beet crops. This policy has been conducive to the permanence of the industry. Factory managers in this State pay as high as \$20 an acre rent. In several instances they have secured tracts containing over 1,000 acres.

Results are now generally encouraging. Four new plants have been established recently—those at Hamilton, Visalia, Corcoran, and Santa Ana. On account of favorable conditions for making long campaigns, the factory managers are strenuously endeavoring to extend the planted areas. Irrigation is now utilized quite extensively in producing sugar beets. Irrigation water is drawn from running streams, from flowing artesian wells, and from wells requiring pumps. In many parts of the State water is found in strata near the surface. If it does not rise to the surface naturally, it is pumped into ditches by means of electricity, gasoline, or other power.

Traction engines and gang plows are used considerably for breaking up the soil, also for propelling train loads of beets to the factory. The producers are investigating the feasibility of using the traction engine for harvesting.

The crops generally produced in the State are well adapted to rotation with sugar beets. They are wheat, oats, rye, barley, alfalfa, melons, potatoes, and other root crops. These crops also offer in connection with sugar beets, pulp, and waste molasses, a substantial stock-food ration which encourages the feeding of cattle and sheep and also promotes the dairy and creamery business.

Alkali exists in the soil of California to a greater or less extent. It is found that sugar beets thrive better than most crops on alkali soil. They gradually extract this salt from the soil, leaving it freer and in better condition for other cropping. Sometimes this land is improved by tile drains.

The greatest advantage which California has over other States in growing sugar beets lies in the length of its planting season. In many cases beets may be planted from the middle of November to the 1st of January. There are whole factory districts that can be so planted. On account of this it is possible to arrange for long factory campaigns. Seeding can be so arranged as to have beets maturing at different times. The factory begins work as the earlier plantings mature, and continues until the maturity of the latest crops. Beets can also be left in the ground until they are needed, and they are not so liable to deterioration as if harvested and placed in bins. A sugar factory in California can easily double the days of its operation as compared with those farther east. Factories in the Eastern States, Mississippi Valley, Colorado, and Utah can not prolong their campaigns in this way. Beets must not be allowed to freeze and thaw, but they are not injured by freezing if they are kept frozen solid until worked.

The beets produced in California as a rule run very high in sugar content. Beets grown for one plant in California during 1909 averaged during its campaign 20 per cent of sugar with a purity coefficient of 85. This is certainly a remarkable achievement. Nothing like it has occurred anywhere else.

During the past season the beet growers of California produced 882,000 tons of beets on 83,000 acres, or an average of 10.63 tons per acre. At an average of \$5 per ton these beets were worth \$4,410,000. The factories produced from these beets 127,272 tons of sugar, worth, at \$4.50 per hundredweight, \$11,454,480.

Climatic and other conditions at the various plants throughout the State in 1909 were as follows:

ALVARADO.—Normal conditions prevailed in the beet-growing area around Alvarado. No serious difficulties were encountered by the farmers. The campaign began early in August and was quite satisfactory to all concerned.

LOS ALAMITOS.—Normal conditions prevailed through the growing season of 1909. There was sufficient rain to put the soil in good shape for seeding. After the beets were through the ground and during their early growing period there was an abundance of rain. This was followed by constant sunshine which resulted in beets of high sugar content and excellent quality. The army worm did some slight damage resulting in a loss of about 200 acres in all. Cattle are fed in the vicinity of the factory. There are also large dairies in

this vicinity which feed the pulp from the factory. These dairies produce the principal milk supply for the city of Los Angeles. It may be stated that stock feeding has increased considerably on account of the use of beet pulp.

Up to date no fertilizers have been used on the land, but the factory is organizing a department for trying out the various kinds of commercial fertilizers.

Weather conditions were quite favorable for harvesting. The campaign of 1909 is considered the best enjoyed by the factory since its beginning.

I clip from the Beet Sugar Gazette, of Chicago, a report from the local correspondent for this district showing average results which can hardly be duplicated anywhere in the world:

The sugar factory here starts off with a hop, skip, and jump, as though glad to be released from the long period of inactivity between runs. Being in the midst of what was once a great sheep ranch, it is well located to receive beets from all directions by team. An additional supply is also received by rail from Buena Park and Sugar (the latter place being in the peat-land district).

The tare-room tests of the beet deliveries to date follow:

Date.	Per cent of sugar.	Coefficient of purity.	Date.	Per cent of sugar.	Coefficient of purity.
July 19.....	21.2	86.9	July 23.....	19.4	85.8
July 20.....	21.2	86.7	July 24.....	21.2	86.9
July 21.....	21.0	86.9	July 26.....	21.3	87.1
July 22.....	19.9	85.6	July 27.....	21.2	86.9

These are on a par with the first deliveries last year, although the start is a week earlier this year.

SPRECKELS.—The sugar-beet lands in the vicinity of Spreckels enjoyed an unusually favorable season. On account of heavy rainfall the soil was in excellent condition for planting and for growing beets. The yield was more than normal and the beets were of excellent quality. This factory has a capacity of 3,000 tons, and its beet-growing area is large.

BETTERAVIA.—In the Betteravia beet-growing area there was too much precipitation for best results, the rains interfering to some extent with the cultivation of the beet crop. The total rainfall was 28.09 inches. However, a magnificent crop of beets was grown. The latter part of the growing season proved more favorable and it was especially so at the harvest. The beets were of excellent quality.

Like other factories in California, this plant does not dry its pulp, although it turns out an immense quantity. This is fed to beef cattle. There are 6,000 head feeding on this pulp. The plant had a campaign of nearly five months.

CHINO.—This is one of the older beet-growing districts in California. It produced sufficient beets during the season to operate the mill for

more than one hundred days and shipped nearly 100,000 tons to be worked up in another factory belonging to this company at Oxnard. Four or five years ago it was difficult to procure enough beets in the district to run this plant. This illustrates the progressive tendency of the beet-sugar industry in our older factory districts.

No plant diseases or insects seriously affected the beet crop. About 2,000 head of cattle were fed from the pulp turned out by the factory, in addition to that consumed by ranchmen for general stock feeding, milch cows, etc.

OXNARD.—This is the ideal plant engaged in the beet-sugar industry in the United States. It has given substantial results from the beginning. Although next to the largest plant in the United States, having a capacity of 2,000 tons of beets per day, it always operates a long campaign. Its results are so favorable that all interests are united in its behalf. The yields per acre are satisfactory and the quality of beets next to the best in the State.

Some damage to the growing crop was caused by the beet-root aphid; also some slight damage throughout the beet-growing area from cutworms.

Cattle and sheep are fed quite extensively in the vicinity of the factory. About 10,000 head of fat cattle are turned off each year.

Turning under green crops is about all that is done at present to improve the soil, and this is practiced on account of the lack of humus.

The factory was overhauled and quite extensive changes and improvements were made in the machinery. The results of the campaign this year are quite satisfactory. The plant exceeded its rated daily capacity most days of its run. The highest yield per acre was 27 tons. The highest reported percentage of sugar in the beet was 24.3.

The fall rains favored early planting. Heavy and continuous rains during February and March retarded the thinning. Unevenly distributed precipitation and the cold spring reduced average tonnage per acre. Clear and dry days during ripening season favored high sugar and purity.

VISALIA.—This is one of the newest plants, and its capacity is small. Weather conditions were favorable. No beet diseases or insect pests were observed. Gophers did some damage here and there. Cattle are fed on pulp to a considerable extent in the vicinity of the factory. No fertilizer is used on the beet lands except refuse lime from the filter presses. Interest in beet growing is gradually developing.

CORCORAN.—A factory of 600 tons capacity was operated here this season for the first time. No beet diseases or insect pests affected the crop. Weather conditions were favorable. Only a limited acreage was put in, but a fair supply of beets was received and they

were of excellent quality. Cattle are fed to a limited extent on the pulp produced by the factory, and there is a tendency toward a larger interest in stock feeding.

HAMILTON CITY.—The winter rains continued a little late and were so excessive as to belate the planting of crops. This had a tendency, however, to place the soil in good condition for plowing and planting. Favorable weather conditions prevailed during the growing season.

An interesting experiment was made in this district; 500 acres which had been planted to beets for three years were this season seeded to wheat and barley. These fields of wheat and barley were the admiration of the beholder during the growing season and finally gave the best yields and the finest quality of wheat and barley ever produced in this locality.

The yield of beets was quite satisfactory and the average quality of the beets was unusually high. Rains somewhat interfered with the harvest. The campaign for the year was considered generally satisfactory.

SANTA ANA.—This factory of 600 tons capacity was in operation this year for the first time. Weather conditions throughout the season were quite favorable. There was some damage due to the army worm. The average yield of beets for a first campaign was the best that has ever been recorded in the State. Some feeding and dairying are carried on in the district, considerable pulp being consumed. This district is not far from Los Angeles, and will have the benefit of that market for stock and meat products. Fertilization of land is not practiced to any great extent. This factory had a very satisfactory run for the first campaign.

COLORADO.

Colorado again shows up as the banner State in producing sugar. It has an experience of one decade in this industry. This period seems short to demonstrate the possibilities of a great industry. The results achieved, however, speak in no uncertain way. There are not merely indications of great possibilities; they are great possibilities realized. They are the fulfillment of the highest hopes and predictions of those who began the installation of the industry ten years ago. In 1898 Colorado was not considered of great agricultural importance. In 1899 a sugar factory was established at Grand Junction. This was followed soon by others at Rocky Ford, Sugar City, and Loveland. Factory building continued until 16 plants were in operation. Colorado is the largest sugar producer in the United States and likely to continue so for some time. Other mills will soon be built. Agriculture is now one of the chief resources of the State. The crops most largely produced are hay—especially alfalfa—potatoes and other root crops, wheat, oats, barley, rye, and melons. It

is also becoming one of the greatest deciduous fruit growing States in the Union. Colorado apples, pears, and plums are unexcelled anywhere. The conversion of so much of the area into farming districts has opened up extensive opportunities for the production of live stock—cattle, sheep, hogs, and horses.

Great things have been accomplished in ten years, and the results have been due largely to the beet-sugar industry. And yet Colorado's industrial development has only well begun. The Gunnison Tunnel—one of the largest irrigation projects in the world—has just been completed. This illustrates the scope and ability of engineering science as applied to irrigation. In order to get the water on the land, a mountain was pierced with a large tunnel, bringing under subjection a large area of new lands. Other large projects are under construction. In this State there are great opportunities for storing water—the Rockies are extensive accumulators of snow deposits. Reservoirs of cement and stone are being constructed to hold these waters until needed for irrigation.

Colorado is also trying out systematically, confidently, and thoroughly the system of "dry farming." The lands are generally fertile, productive, and quite free from stone and other obstacles. Some of them are not susceptible to irrigation, as they can not be reached with an irrigation ditch. In such cases it is proposed to produce certain crops by scientific cultivation, by packing, mulching, etc., to conserve the moisture in the soil.

The acreage planted to beets in Colorado during 1909 was considerably larger than usual. While the season started off quite propitiously, the weather was less favorable as the growing season advanced. There was too much rainfall. One of the difficulties of irrigation is the inability of the farmer to judge to what extent it should be applied. Too much water is detrimental as well as too little. The purpose should be to apply irrigation water sufficient to supplement the moisture from rainfall. During the past season rains often came soon after irrigation, resulting in too much moisture for the crop. This lowered the quality of the beets. The early hard freezing caught many of the beets in the ground. However, the State produced considerably more beets and sugar than in 1908 with the same number of factories.

There were 121,698 acres of beets harvested in the State during 1909. From this planting 1,257,000 tons of beets were produced, the average for yield being $10\frac{1}{2}$ tons per acre. For these beets the farmers were paid, at \$5 per ton, \$6,284,000. From the total amount of beets produced 149,405 tons of sugar was manufactured. The value of this sugar at prevailing prices, $4\frac{1}{2}$ cents per pound, was \$13,446,000.

ARKANSAS RIVER FACTORIES.—Located in districts tributary to the Arkansas River in Colorado are 6 factories, located at Rocky Ford, Lamar, Las Animas, Holly, Swink, and Sugar City.

The experiences of the factories along the Arkansas River were so much alike that I will discuss them together. Weather conditions were quite normal throughout the season. Beets produced were of excellent yield and good average quality. The harvest season was the disastrous part of the year's experience. Heavy snows and hard freezing very much retarded the work in the fields. Melting snows and continuous freezing placed the roads in such shape that it was almost impossible to deliver the beets. It was necessary to run the factories at half their daily capacity. The cold snap came when the roads were badly cut up. After freezing they were almost impassable. This interference with the harvest was a great drawback to all the factories along the Arkansas River. It meant a serious loss to the factories and to the farmers. Its effect will be felt for some time to come.

EATON.—The Great Western Sugar Company owns all of the 9 factories in northern Colorado. They are located at Eaton, Greeley, Longmont, New Windsor, Loveland, Fort Collins, Sterling, Fort Morgan, and Brush.

The spring was late and cold. This delayed planting. The weather was quite favorable during the growing season. An early freeze with late rains had a tendency to lower sugar content of the beets. There was some leaf spot, also a few light hailstorms were in evidence in this district, doing no extensive damage. The factory is not drying pulp, but the pulp is consumed in the district by feeders of cattle and sheep. Feeding is quite extensive. No fertilizer is used on the soils except barnyard manure. Rotation of crops with alfalfa as a base is practiced. The climatic conditions of the season tended to increase the tonnage and lower the quality of beets. Factory results were in the main quite satisfactory.

GREELEY.—The season started late, the weather being unfavorable for early planting. Later the district experienced favorable climatic conditions during the summer. An early freeze and late rains materially interfered with the harvest. There was a good yield of beets whose quality was not up to the usual standard.

This is one of the largest successful plants of the country. As yet it has not installed a pulp-drying plant. Feeding stock of all kinds is carried on very extensively in this district, and there is a demand for all the pulp from the factory. The increasing demand for pulp is gradually raising the price. It now sells for 60 or 80 cents per ton. This is double the amount formerly received.

Some leaf spot appeared in the fields, also hailstorms did a little damage. Some damage was done to the beets by "worms." In some beet fields the leaves were stripped from the beets, but a new set grew again, after the "worms" had disappeared, leaving the beets apparently uninjured. Taking everything into consideration, while

abnormal conditions prevailed at different times; the results of the season are quite encouraging.

LOVELAND.—Weather and other conditions here were quite similar to those at Greeley and Eaton.

The Loveland factory was the third built in Colorado. It is a large concern and has had an unusually successful career. For years the farming district has engaged extensively in sheep feeding, and many cattle are now fed in this district. Pulp is very popular with the feeders, and this concern is able to dispose of its entire output. The lands used in growing the beets are mostly old cultivated farms. Wheat and other small grain, alfalfa, and potatoes are grown extensively. The yield of beets this season was quite large, but the quality of the beets was not up to the standard of some former years. On the whole, the factory results were satisfactory.

NEW WINDSOR.—This plant experienced about the same conditions as those at Greeley, Eaton, and Loveland. The spring was late and cold, but the weather was fair during the growing season. Unfavorable conditions prevailed during the early part of the harvest. Some leaf-spot appeared and hailstorms did some damage; also insect pests appeared in places, but the damage from all of these things was inconsiderable. The yield of beets was fair and results for the season generally acceptable.

LONGMONT.—Longmont factory district experienced about the same conditions as those of other factories in northern Colorado. Results in this district were in the main satisfactory.

FORT COLLINS.—Fort Collins is located in an old-established farming district, where sheep and cattle are fed extensively. It disposes of its pulp readily to local feeders. Its lands were in excellent condition for taking up the beet-sugar industry. Fort Collins is the location of the State Agricultural College and the State Experiment Station. These two institutions have given the beet-sugar industry and its allied interests considerable investigation. They have been generally helpful to the industry throughout the State, but especially so in the vicinity of Fort Collins.

The yield of beets in 1909 was heavier than usual, but the quality was not up to the standard. The campaign may be rated as generally satisfactory.

STERLING, FORT MORGAN, AND BRUSH.—These are the newer plants of the great Western Sugar Company. Lands growing the beets are irrigated from the Platte River. Conditions around these factories are somewhat different from those prevailing around the other six plants of this company. Most of the farming lands are newer. In these districts no great progress had been made in agricultural development prior to the installation of the factories. With the establishment of these plants, conditions have rapidly changed. Stock feeding

is increasing and general cropping is engaged in more extensively. The farming districts which produce beets for these factories also produce alfalfa extensively. They have ideal conditions for greatly increasing the animal industries. They have the alfalfa, the sugar-beet pulp, and the small grain for a balanced stock-food ration. The other crops are well adapted for rotation with sugar beets.

Weather conditions were quite favorable throughout the growing period of the year; but early snows and freezing and thawing hampered to a considerable extent the work in the harvest fields and also lowered the sugar content of the beets. The yield of beets was quite satisfactory, a point in favor of the farmers, and the general results were satisfactory at all the plants.

GRAND JUNCTION.—Weather conditions were quite favorable during the growing period of beets in the Grand Junction district, but heavy rains in September at the beginning of the harvest lowered the sugar content.

The output of pulp of this factory is sold by contract to a local feeder. It is consumed by cattle in feeding pens near the plant. No fertilizer is used on the lands except manure.

This factory is located in the western part of the State. Water for irrigation comes from Grand River. This is the largest fruit-growing district in Colorado—one that produces fruit of fine quality. One of the main obstacles encountered originally by this factory was the competition of fruit-growing farmers, who were loath to give up their lands to sugar beets when they gave such excellent results in the production of fruit. The plant was not able for several seasons to secure a sufficient supply of beets. It was closed down for a couple of years on this account. This has all been overcome now, and it is one of the successful enterprises in the State. It has had several years of very satisfactory results. This year the yield was good and the quality fair. The factory had a larger supply of beets than in any previous year. Results were quite satisfactory both to the factory and the farmers.

IDAHO.

The four beet-sugar plants in Idaho, the property of the Utah-Idaho Sugar Company, are the outgrowth of the development work of that company in Utah. They are located at Idaho Falls, Sugar, Blackfoot, and Nampa. Conditions in this State are quite similar to those in Utah. The State has a large area available for the extension of the beet-sugar industry. The lands are fertile, comprising a number of valleys with running streams for irrigation. There are many opportunities also for storing water in the mountains. For these plants irrigation water comes from the Snake River.

Idaho is one of the best fruit States in the Northwest. Its apples and other deciduous fruits are of fine quality. It grows alfalfa, potatoes, and small grain. It also produces sheep and cattle. Being a new State, transportation and irrigation facilities are as yet deficient. The beet-sugar industry has done much to stimulate improvements, and a large number of irrigation projects are now under consideration.

The company operating the factories found it necessary to install at one of their plants a pipe line for delivering the juice to the factory on account of difficulties in transportation, the same as in Utah.

Indications point to considerable extension of the beet-sugar industry in Idaho in the near future. We have in this State a large Mormon element. They have the same industrial training and frugal tendencies as those of Utah. This is a favorable and significant fact. It portends much for the development, success, and future extension of the industry.

NAMPA.—In the Nampa district the crop early developed bad tendencies. The beet-leaves began to curl. Beet blight was very much in evidence. The "white fly"^a that did so much destruction in Idaho and Utah three or four years ago became quite active. This was followed by drought. As the season advanced it became evident that the campaign for Nampa was doomed and the management decided not to operate the plant. The beets harvested were sent to the company's factory at Blackfoot to be worked into sugar. Nampa is the company's newest factory in Idaho. The lands growing the beets were recently reclaimed from the sagebrush. It gives every evidence of being a strong district when its conditions shall have thoroughly developed. It is unfortunate that such an experience should have overtaken this new plant. However, the company is one that is prepared to meet such obstacles and overcome them.

IDAHO FALLS.—In this district the spring was cold and dry. This and an early winter made the growing season very short. However, during this period favorable conditions predominated, producing a fairly good crop of beets. The yield was good and the quality of the beets excellent. There were no plant diseases nor insects attacking the beets in this district. No hailstorms nor disastrous floods appeared. This plant is not drying its pulp. In the vicinity of the factory cattle and sheep are fed extensively, utilizing the output of pulp. Barnyard manure is the only fertilizer applied at present.

SUGAR.—Weather conditions were quite favorable in the beet-growing area of this plant during the season. A few cutworms and

^a A local name for the beet leafhopper, which is the principal cause of "curly-top."

leaf worms did some damage to the beets. The work of these pests was studied by Prof. H. B. Shaw, Bureau of Plant Industry, and under his direction the beets were sprayed, many of the worms were destroyed, and the beets generally benefited. The pulp produced by this plant is not dried, but is all fed in the wet state to cattle and sheep in the vicinity of the factory. Stock feeding is quite extensive in this district, largely through the improved conditions brought about by the sugar factory. No commercial fertilizer is used in the beet fields, but barnyard manure is applied to the soil. Alfalfa is grown quite extensively in rotation with sugar beets. Mr. Mark Austin, the efficient agriculturist of this plant, says:

Beet culture has raised the standard of farming in this district 100 per cent, increasing the fertility of the soil by furnishing the farmer a cultivated crop, thus making it necessary to plow deep and rotate, which is the only permanent and profitable system of farming.

BLACKFOOT.—The district growing beets for Blackfoot enjoyed a very favorable season throughout. Sufficient warm rains were received to start the beets growing in a healthy condition. The stand of beets was uniformly good. Warm weather and occasional showers continued throughout the growing season. On account of the abundance of water, weeds and grass were unusually prominent. Conditions were favorable for cultivation and an excellent crop of beets was produced. The yield was good and the quality excellent. Favorable weather continued throughout most of the harvest. Cold weather set in about the middle of November, delaying the harvesting of the beets to some extent.

MICHIGAN.

Michigan is one of the principal sugar-producing States of the Union. It has been producing beet sugar eleven years. Colorado and Michigan each has 16 factories. However, the yield of beets is heavier and the planted area larger in Colorado, and its output of sugar considerably exceeds that of Michigan.

Factory building proceeded too fast in Michigan. It has been necessary to dismantle half a dozen plants and move them to other places offering better opportunities. These failures had much to do with retarding the progress of the industry in the State, and it has taken considerable time to overcome the discouraging effects. Michigan farmers have never been overzealous in the development of the agricultural resources of the State. They hesitated at sugar-beet growing. If this had been presented more gradually it would have succeeded better. The farmers should have been given time to grow up to the requirements and necessities of the case; but they were hurried into a new, untried undertaking. In two or three years six plants were constructed in the vicinity of Bay City. The farmers

were urged to grow the beets. Often they were induced to plant larger areas than they could successfully manage. Owing to this, factories got but a limited supply for their annual campaigns and the farmers became discouraged. In addition the industry encountered a series of years unfavorable to sugar-beet production, being either too wet or too dry. The sugar companies of Michigan have spent several years endeavoring to overcome the effects of this hasty, ill-advised action in establishing beet-sugar plants.

The past year was in many respects the most prosperous for the industry in this State since it began. Factories as a rule had considerably larger tonnage than usual, their campaigns were longer, and their beets better.

Nearly all the factories in Michigan for a considerable time were compelled to dispose of pulp as waste, and some of them are still doing so. In order to avoid this, many of the plants have installed drying plants to make their molasses and pulp by-products into a stock food. When so prepared, with the moisture expelled, it is a dry, flaky substance, amounting to about 5 per cent of the original weight of the beets, and it sells at \$20 to \$25 per ton. The dry matter of the beet is about 10 per cent of its original substance. The factory will turn out in wet pulp a quantity amounting to about 50 per cent of the original weight of beets. This dry stock food product can be sacked and shipped to all parts of the country like bran and other mill feeds. It is a valuable ingredient in a ration for animals on the farm or in the cities and towns. This food product can be shipped long distances and it is not, therefore, dependent upon a small locality for its market like the wet pulp turned out by the factory. One company owning six sugar plants in the State has installed five drying plants.

On the whole the weather conditions in the State during the past year were rather unfavorable. The spring was cold, wet, and backward, but more favorable weather prevailed during the growing season, though there was considerable tendency to drought. The weather was especially favorable for harvesting beets. This is a critical period. Dry weather lessens the work and improves the beets. It is estimated that 25,000 laborers were employed in the fields growing Michigan's beet crops during the past year. With other improvements that have taken place must be mentioned the higher price paid the farmers for the beets. When they began growing beets they received net \$4 per ton; this year they received about \$5.50.

The Michigan Sugar Company, with six factories, paid its farmers in one month (October) \$1,000,000. It must be evident that the payment of such large sums in a small community must affect the prosperity of all concerned.

BAY CITY.—The weather was very favorable for beet growing in this district, being a little too dry during the month of August. The factory had secured a large acreage, the yield was fair, and the quality of the beets was exceptionally good.

This plant has an auxiliary plant for preparing a dry stock food from pulp and molasses. Considerable wet pulp is fed in this vicinity to cattle, sheep, and hogs.

The district uses different kinds of commercial fertilizer, also barnyard manure. Clover crops are plowed under.

CARO.—The plant here, of 1,200 tons capacity, was among the earliest erected in Michigan. It has had considerable adverse experience, but is now one of the most successful plants in the State. Shortly after its erection it had to be overhauled at heavy expense and greatly improved. It has been considerably enlarged. Weather conditions during the season were ideal in about one-half of the territory growing beets for this factory. In the other half it was too dry. Wire worms did a little damage. The factory had the largest planted area since its beginning, and it harvested nearly all the land planted to beets. The yield of beets was good, and the quality better than in any other season in the history of the factory. This plant is drying its pulp. Stock feeding is limited in the district. Some wet pulp is used by the local feeders, but most of it is marketed in the prepared state. Farmers use a variety of commercial fertilizers, apply whatever barnyard manure is available, and plow under green crops of clover.

ALMA.—The management secured a larger contract area than usual. A cold, wet, backward spring interfered with seeding. Most of June and July was ideal weather, followed by drought, which somewhat lessened the tonnage. The yield, on account of dry weather in August, was lighter than usual. The quality of the beets was excellent. This plant is drying pulp, though some of the pulp was sold locally to dairymen and for fattening cattle and sheep. Commercial fertilizers of various kinds are used on the beet lands; also barnyard manure and green manure.

CARROLLTON.—The spring was wet and cold in this district. This was followed by very dry weather in the summer. Floods did considerable damage shortly after seeding. The yield of beets was light, but the quality was exceptionally good. At most of the factories in Michigan beets are bought on a sliding scale, and high quality repays to the farmer much of his loss through light yields.

This plant is drying pulp. Some cattle are fed locally, and to a limited extent wet pulp from the factory is used. Mixed commercial fertilizer is generally used by the farmers; also barnyard manure. Green crops of clover are plowed under.

SEBEWAING.—It was too wet and cold during seeding time, and abnormally dry from June to August, the most important part of the growing season. The weather was exceptionally fine during the harvest. The yield of beets was fair and the quality exceptionally good.

The plant is drying its pulp. Local feeding is not extensive, but some cattle are fed pulp from the plant. Most of the output of this product, however, is shipped away. Commercial fertilizer is used generally to replenish the soil with potash and nitrogen. For the latter purpose barnyard manure and green-manure crops are also used.

CROSWELL.—The spring was wet and cold and very late. Very few beets were planted before June. July, August, and September were excessively dry and hot.

Considerable damage was done in this district by wireworms and "white grubs." The yield of beets was fair and the quality good. This plant is not drying its pulp, but plans are matured for putting in a drier next year. Much of the pulp is consumed locally for feeding sheep, cattle, and hogs.

In the past, covering a period of many years, this district has been growing hay quite extensively. The land is deficient in humus and its fertility is somewhat depleted. To improve them the farmers are now using barnyard manure, green manure, and to some extent commercial fertilizers.

BAY CITY, W. S.—Weather conditions were quite favorable, a little wet and cold in the spring, but more favorable during the growing season, with some tendency to drought in August. The yield of beets was fairly good and the quality exceptionally high. This is one of the oldest plants operating in Michigan, and has had to maintain its existence in close competition with several near-by plants. Beet growing has increased in favor with the farmers in the last few years, and the plant now secures a larger acreage and operates longer campaigns.

HOLLAND.—Weather conditions were quite unfavorable in this district. In the spring it was too wet and cold, delaying planting considerably. This was followed by drought. In general the season was the most unfavorable the factory has experienced since its beginning. This plant has no pulp drier. It depends upon local feeders for disposal of its pulp. In many respects this factory district has advantages. Factory results have generally proved satisfactory. The past year appears somewhat of an exception. The yield was light and the quality of the beets about normal.

Owosso.—Too much rain in the spring interfered with planting in this factory district. Some of the land had to be replanted to other crops. This shrinkage in the beet area was caused by late

rains, continuing throughout May and June. July, August, and September proved quite dry. The precipitation in May was 2.53 inches, in June 2.44, in July 1.77, in August 1.23, and in September 1.88. This district succeeded in bringing to the harvest most of its planted area. The yield was below normal. The quality of the beets was excellent.

A new beet harvester was used in this district with good effect. It combined the work of loosening, lifting, and topping the beets. This plant is drying its pulp for the market. Stock feeding is not extensive. Some of the pulp is used locally, but most of it is shipped to other places. Farmers generally use a combination ready-mixed fertilizer.

LANSING.—Rains were excessive in the early part of the season, delaying planting and healthful germination of the plants. This was followed a little later by drought. Weather was quite favorable during the harvest season. This factory is not drying its pulp, and depends upon local demand for disposal of its product. Local feeding is not extensive. The pulp product has not yet impressed itself on the local community as a desirable feature of importance.

The factory secured a very satisfactory acreage. The yield was not very satisfactory, which fact was offset to some extent by the excellent quality of beets.

BAY CITY, STATION A.—This plant is located in close proximity to those at Carrollton, Bay City, and West Bay City, and the seasonal and other conditions described for those plants apply as well to this one.

MOUNT CLEMENS.—Conditions in this factory district were quite satisfactory during the year. The season started a little late, wet, cold weather interfering to some extent with planting and germination. Conditions were more favorable during the growing period. This factory is of 600 tons daily capacity, and its planted area was large for a factory of that size. Its campaign extended nearly four months, which is unusual for Michigan. During many days of the campaign the plant exceeded its rated capacity from 50 to 150 tons per day. The yield of beets was small, but the quality was excellent. The results of the campaign may be considered fairly satisfactory.

MENOMINEE.—This company has a plant of 1,200 tons daily capacity. It is one of the largest in Michigan. It is located on the upper peninsula. A considerable part of the beets for this plant is grown in Wisconsin. The place is favorably located for delivery of beets. Its beet-growing areas are near the arms and small bays of Lake Michigan, and the beets are brought to the plant on barges. This factory has had a rather strenuous experience in its efforts to secure a sufficient acreage for a satisfactory supply of beets. It has been

persistent and patient and is gradually achieving this end. Its management is progressive. At considerable expense it has studied many features of the industry. It investigated the feasibility of drying beets, preparing them to withstand a longer period in the bins; also of establishing local stations throughout its beet-growing area where this preparatory work may be accomplished, thus lessening to a large extent the weight of the raw product shipped to the factory. The results of such a method, if successful, would lengthen the campaign of the sugar factory indefinitely.

In overcoming the difficulty of a supply of beets this plant probably has had a more arduous job than any other plant in Michigan. While it has not yet reached satisfactory results in this respect, it is gradually and surely advancing toward success.

Weather conditions were about normal in 1909, a little too wet and cold in the beginning, but more favorable during the growing period. The yield was not heavy, but the quality of the beets was exceedingly high, which compensated to a large degree both the growers and the management.

ST. LOUIS.—The season started off quite wet and cold in the early part, and planting was delayed. Considerable dry weather followed, and conditions were favorable during the latter part of the growing period and during most of the harvest. This plant secured a very satisfactory contract area. The district succeeded in bringing to harvest most of the beets. The yield was poor, but the quality of the beets was excellent. The results of the campaign were generally considered satisfactory. This plant has a pulp drier. Most of the dry product is shipped away to other places, as stock feeding is not very extensive in the district.

The sugar-beet growers generally use a mixture of commercial fertilizers on their lands. This is prepared especially for sugar-beet production, and about 150 pounds is sown to the acre.

BLISSFIELD.—The season throughout was quite dry, reducing considerably the yield of beets but promoting their quality. A new implement was introduced in this district for trial, known as the beet harvester, blocker, cultivator, and fertilizer distributor, but I am not able to report regarding its success.

This factory is not drying its pulp. Stock feeding is carried on in the district quite extensively. Commercial fertilizers are used quite largely and are considered very beneficial. The results of the year were a light yield and a very high quality of beets.

CHARLEVOIX.—No report concerning seasonal conditions has been received, but the acreage and yields reported indicate that the conditions were similar to those affecting other Michigan factories. The beets produced were of excellent character, but the tonnage was not heavy.

UTAH.

Considering everything, Utah is the ideal beet-sugar State. Its conditions as a whole are more uniformly favorable than those of any other State. Beets are grown almost exclusively by irrigation. Its natural conditions are quite similar to those of Colorado. It has about the same semiarid climate, and the soil is of the silt variety.

In Utah the industry fell into the hands of a hardy, frugal, industrious class. The farming districts were already thickly settled. The farms were small, running from 10 to 20 acres, 40 acres being a large tract for one farmer to control, and as a rule these tracts were the homes of large families. Necessity required that these farms produce the most and best, as they must afford sustenance for a denser population. Methods of cultivation, irrigation, drainage, and fertilization were superior to those prevailing in ordinary farm districts in other parts of the country. Irrigation had reached a higher development than in any other place in the United States. These farms had been brought to this high state of utility by the Mormon people. It had been accomplished by incessant toil, and through hardships and deprivations. The people were accustomed to close cooperation under a directing head in executing plans devised by men of superior ability and resources. This society sent its best members as missionaries and teachers to foreign countries, and from these countries they brought back methods and systems of industrial organization and valuable information resulting from European research. Where applicable, these were included in the system of quasi cooperative endeavor in the Mormon settlements throughout Utah. When the Mormons entered Salt Lake Valley and scattered throughout other areas tributary to it they found a wild, arid, uninviting country. Through industry, cooperation, and systematic direction they have made it one of the most productive, beautiful, and desirable in the United States. There were no drones among this people. Everybody worked. Education was not neglected. It became a part of the system, was organized as the basic principle of industrial effort. These settlements were augmented from time to time by new recruits from the older States and foreigners from all parts of Europe. Their organization was effective and it amalgamated these different elements into a homogeneous people, striving for each other for the improvement of their conditions.

We find no sporadic growth of industry in this State. Those responsible for its growth were contented to await a logical development. Beet-sugar factories have followed the demands of the growers. Extra facilities for making sugar were installed where there was a demand for them and where needed. The factory at Lehi was the first installed in the State and the first equipped with American-made machinery. It had a capacity of 300 to 350 tons

per day. Its beet-growing area outgrew its capacity. Railroad facilities for shipping beets were inadequate. The pressure of the mines shipping ore and producers of other crops delivering to market absorbed the cars. The factory was unable to secure shipping facilities for their beets at the time needed. The management installed a pipe line to Springfield (a distance of 19 miles), located in a large beet-growing territory, and thus delivered the juice to the factory instead of the beets. In connection with the pipe line, a slicing plant was installed to slice the beets and extract the juice. This juice was mixed with milk of lime to preserve it until used, and was then pumped through this iron pipe to Lehi, where it was worked into sugar. In time another slicing station was installed for this plant, and finally a third. These stations work up the beets grown in the immediate vicinity. The sugar-extracting capacity of the main plant was enlarged sufficiently to work up the juice from these subsidiary plants in addition to that from the beets grown in its own vicinity. It now has a capacity of 1,200 tons of beets per day. This pipe-line system is peculiar to this company's plants. In time a new factory was needed at Garland. This, with a capacity of 1,200 tons of beets per day, has been in operation several years. The company's operations have spread out into Idaho, where it has four plants. All these plants in Utah and Idaho are the natural outgrowth of the company's operations in the sugar industry beginning with Lehi. Beet producing for this company's plants in Utah is becoming so heavy that another plant will be needed soon. This has been under serious consideration for two or three years. It will probably be located somewhere in Sevier County.

The beet pulp is all used for feeding purposes in this State. The factories receive 50 cents per ton. Eventually they will receive considerably more.

Over 130,000 tons of beets were produced for the Lehi factory during the past season. The factory turns out in wet pulp about 50 per cent of the original weight of beets. Therefore it received about \$25,000 for its pulp. This is an important item. It would give a dividend of $2\frac{1}{2}$ per cent on a million-dollar investment. This is very different from throwing the pulp away as waste. It is a great advantage to a factory when its farmers can be induced to utilize this valuable stock food. Experiments in feeding pulp in comparison with other feeds in different parts of the country has shown that it is worth from \$1.50 to \$2.50 per ton.

The most serious difficulty encountered by the industry in Utah was the depredations three years ago of an insect called locally "the white fly." In a short space of time this fly destroyed 25—in some cases 75—per cent of the crop. Its depredations were confined to a single year. It has appeared since in limited numbers in a few places, but has not been serious.

Climatic conditions throughout the State during the past season were quite favorable. The yield of beets in Utah has greatly increased since the State began the industry, and the yields of other crops have also increased. The soil is permanently in better condition, and the sugar industry is now thoroughly intrenched.

OGDEN, LOGAN, AND LEWISTON.—The Amalgamated Sugar Company is operating sugar factories at these places in the northern part of the State with capacities as follows: Ogden, 400 tons; Logan and Lewiston, 600 each. Natural conditions surrounding these factories and climatic conditions during the past year were so similar that they may be considered together.

A few years ago it was most difficult to induce the farmers to grow the beets, either for Logan or Ogden. Gradually this difficulty was overcome, and the factories secured constantly increasing supplies of beets. Then a factory was built at Lewiston. This season all three secured ample acreage, had abundant supplies of beets, and operated campaigns of about four months. Other factories will be needed in this section in the near future. Facilities for beet growing have very much improved since the industry began in this part of the State, the principal development being the construction of the Bear River Valley Irrigation and Power Ditch. This affords an abundant supply of water for irrigating a large body of land, and it furnishes power and light for Salt Lake City and the contiguous valley.

During the season of 1909 the weather was very favorable. The yield of beets was exceptionally heavy, the average being higher than ever attained in this section before. The quality of the beets was good. It is planned for next season to extend the capacities of the factories at Logan and Ogden.

LEHI AND GARLAND.—The Utah-Idaho Company is operating factories here with capacities of 1,200 tons each. Weather conditions were ideal in these two districts. There were no outbreaks of plant diseases or insect pests and no floods or hailstorms. Both plants had a large acreage and abundance of beets. The yield was very heavy, and the quality excellent. The results of the season are the best on record for these factories. The campaigns extended over four months. There is considerable dairying and feeding throughout these districts, and the pulp is readily taken by the farmers.

WISCONSIN.

The beet-sugar industry is thoroughly established in Wisconsin, which is one of the best developed creamery and dairy States in the Union. Stock breeding and feeding are also quite extensive. The farm lands are rich and especially productive of root crops. The

State has a large list of agricultural crops and is pretty well balanced in agricultural production. Clover is quite extensively grown and is very productive.

The pulp is largely fed to dairy cattle, thus increasing the barnyard manure available for replenishing the fertility of the soil.

There are four beet-sugar plants in Wisconsin, located and rated as follows: Menomonee Falls, 500 tons daily; Chippewa Falls, 600; Janesville, 600; Madison, 600.

Weather conditions were quite uniform throughout the State and affected all four factory districts very much alike. The factories had larger contracted areas than any previous year. There were frequent rains early in the season, delaying planting. After the weather of spring settled conditions were quite favorable to planting and germination, and favorable weather continued until the middle of July. Then it became too dry. In August there were sufficient rains, and the weather was warm and especially favorable to growing beets. In September rain retarded the ripening of the crop and lowered the sugar content of the beets. Conditions were quite favorable for harvesting and the beets improved. The final results for the year were a fair tonnage and excellent quality of beets. The farmers were well satisfied, because the beets tested high, and they accordingly received good prices.

STATES HAVING ONE FACTORY EACH.

ARIZONA.—After many trials and tribulations the beet-sugar industry has finally adjusted itself to conditions in Arizona. Several years ago a factory of 800 tons daily capacity was installed at Glendale, 8 or 9 miles from Phoenix. This plant is well designed, of good construction, and equipped with modern machinery. Its initial attempt at a campaign was disastrous; however, from several causes. Its working capital was inadequate. Farmers were unaccustomed to intensified cropping. The enterprise had been promoted with too much show of the bright side and not enough of the stern realities. In addition to this the irrigation facilities were inadequate and could not be depended upon. During this first campaign heavy precipitation flooded the irrigation ditch, causing many breaks. The water in the ditch became dirty and unfit for use in the sugar factory. As the factory depended upon the ditch for water for this purpose, it was obliged to suspend operations. The factory was unable to manufacture sugar from which it could pay the farmers for the beets. It fell into difficulties and a receiver was appointed. Many of the beets grown remained in the ground and were an entire loss to the growers. Such a failure naturally proved very discouraging both to the company and to the farmers. Finally, however, the Roosevelt Dam and Irrigation Ditch was finished. This is one

of the largest and most expensive irrigating projects in the world. It gave a new impetus to the beet-sugar industry. The affairs of the management of the factory were adjusted in court and it passed into the hands of a new set of capitalists and managers who were thoroughly experienced in the beet-sugar industry, having promoted and operated other successful plants. It was placed back in commission and was operated successfully during 1909. The factory was enlarged, and automatic country dumps were constructed for the convenience of the ranchers at Mesa, Tempe, and Phoenix. A traction engine gang plow was introduced for stirring the soil and many other up-to-date conveniences were employed. Weather conditions throughout the growing period were quite generally favorable.

Planting for the campaign began in October and extended through most of the winter. The campaign opened July 1 and closed August 4. It was short but of sufficient duration and attended with sufficient success to convince the farmers and all interested that a new era had opened for the beet-sugar industry in Arizona.

ILLINOIS.—Illinois has one beet-sugar factory, of 350 tons daily capacity, located at Riverdale, which has been in operation for three consecutive campaigns. There are some decided advantages in the location of this factory. The soil of its beet-growing area is of the sandy loam characteristic of the lake region. It is near Chicago, and the market for its products is ideal. It is surrounded by an extensive milk-producing population which furnishes a demand for its pulp. It is also in the center of a series of truck farms, producing vegetables for the Chicago market. This affords opportunities for rotation with sugar beets. The whole northern half of Illinois is well adapted to beet-sugar production on account of these advantages of market, soil, and agricultural conditions.

In northern Illinois are many localities well adapted to the beet-sugar industry. They have the soil, transportation, markets, crops for rotation, and a well-trained farming population. The same can be said of the northern portions of Indiana and Ohio, most of New York, considerable of Pennsylvania, and portions of New England. The factory at Riverdale has gradually extended its beet-growing area to new points favorably located. In 1909 it had a larger yield of beets and a longer campaign. Excessive rainfall interfered with early planting and proper preparation of the seed bed. This was followed by better weather conditions. During the latter part of July and early August there was drought, and this was followed by favorable weather during the latter half of the growing period. The yield of beets was satisfactory.

IOWA.—Iowa has one sugar factory, located at Waverly, in a fertile agricultural district. It is in the center of one of the best corn-producing sections of the State, also one devoted to cattle and

hog feeding and stock breeding generally. The district was beset, however, from the beginning with those conservative tendencies of farmers who are accustomed to good yields and profits of other crops. These tendencies affect all the well-established farming districts of the older settled areas in the North Central States and the East.

This plant has struggled to enlarge its scope of action. It has been difficult to procure acreage to furnish it a sufficient supply of beets. The season started off with excessive rain and cool weather. There was a tendency to drought in midsummer. More favorable weather conditions prevailed during the latter part of the growing season, continuing through most of the harvest.

For next year the company reached out and established beet-growing centers at other places in the State available for railroad delivery of beets. Its acreage next year will considerably exceed that of previous years. Already there is much talk of establishing other plants in localities that have been growing beets for this factory.

Stock feeding is quite extensive, and the pulp is readily taken from the factory. As yet no fertilizers other than barnyard manure are used in this district. The quality of the beets grown is excellent. The factory is one of good type.

KANSAS.—There is one plant in this State, at Garden City, of 1,200 tons daily capacity. This is in the western tier of counties near the Arkansas River. Conditions in this district are quite similar to those affecting the plants in the eastern part of Colorado along the Arkansas River at Lamer, Swink, Holly, and Rocky Ford. Results this year were quite similar to those experienced in the fields of those factories.

Conditions in Kansas for producing sugar beets have been quite thoroughly tested in all parts. Many portions of the State are well adapted, especially all that territory lying contiguous to the Arkansas River.

The farm lands producing beets for the plant at Garden City are under irrigation. Underlying all the territory contiguous to the Arkansas River are streams of sheet water within pumping distance of the surface. Wells are sunk and the water brought to the irrigating ditches by gasoline or electric pumps. The Government has established here one of its irrigation projects under the reclamation act. This is an irrigation system where water is supplied entirely from this sheet water and is elevated by pumping. This irrigating system cost between \$200,000 and \$300,000 and is one of the largest of its kind. There are four regular irrigating ditches supplying the agricultural lands in the vicinity of this plant. Several other sugar plants are contemplated in places accessible to these systems of irrigation.

The season of 1909 started quite adversely for best results in beet growing. The spring weather was cool, and winds were excessive and continuous. Drought was prevalent in August, but the rest of the growing period was quite favorable. The harvest started in under favorable conditions and terminated in the early freeze and snows which affected the factory districts in eastern Colorado.

One thousand acres of beets were frozen in the ground and had to be abandoned. The tonnage produced was fair but not as heavy as usual, and the quality of the beets was not quite up to normal. Generally speaking it was an off year for beet production in western Kansas. The plant has arranged for a larger acreage next year.

MINNESOTA.—This State has one plant of 600 tons capacity, located at Chaska. It is the second that has operated in the State. The former was located at St. Louis Park, near Minneapolis, and burned down several years ago. The one at Chaska may be considered its successor, as many of its beets are grown by farmers who produced beets for the earlier plant. It is located in a well settled and developed agricultural district. The soil is a sandy loam, fertile, and well adapted for sugar-beet production. This land quickly drains and is easily manipulated. The cost of cultivation is not great.

Weather conditions were quite favorable throughout the season. The yield of beets was light but their quality was excellent. The pulp for feeding purposes is readily consumed by the farming community.

The factory is about 25 miles from Minneapolis and has easy access to the "Twin City" markets. It is one of the plants of the Michigan Sugar Company. There are two or three other places in the State actively considering the installation of the beet-sugar industry.

MONTANA.—The Great Western Sugar Company, which has nine factories in northern Colorado, also has one factory in this State of 1,200 tons daily capacity located at Billings. Montana possesses many large areas adapted to the sugar industry. In many respects conditions are quite similar to those of Colorado. A number of running streams afford an abundance of water for irrigation. Along these water courses are extensive fertile valleys. The State needs improvement, such as railroads, irrigating ditches, etc. The sugar factory at Billings offers the incentive for making these improvements and further intensifying the agricultural production of the State. A number of new projects are under contemplation. These are along the Big Horn, Milk, Yellowstone, and Missouri rivers.

The weather was a little too cold and wet in the spring, which interfered to some extent with preparation of the land, planting, and germination of seed. Several hailstorms in different places in the district did considerable damage. Otherwise the season was

favorable. The yield and quality of beets were good. Results of the campaign may be considered highly satisfactory.

This factory is not drying its pulp. The district is feeding cattle and sheep quite extensively and there is a ready demand for pulp for feeding purposes.

Up to the present time commercial fertilizers are not in use. Barnyard manure is applied to the soil, and alfalfa is grown to a considerable extent. The soil is rich but somewhat lacking in humus, and manure and green-top fertilizer are required to improve its condition.

NEBRASKA.—The American Beet Sugar Company is operating a plant at Grand Island of 350 tons capacity. This is one of the three oldest plants in the United States. In many respects conditions are favorable for beet production. The soil is a rich sandy loam, easily worked, and it drains quickly. Cultivation is not so expensive as in Michigan, Iowa, and Wisconsin. The district feeds cattle and sheep extensively.

The rainfall during the season was below normal, the weather being unusually dry at a time when beets should have had moisture to make full growth. There were some cases of "leaf-spot," resulting in damage to a number of fields. During the harvest rains followed by early snow terminated the campaign before the crop was all worked up. It may be said that the results of the campaign were not very satisfactory.

NEW YORK.—The Lyons Beet-Sugar Refining Company has been operating a factory of 600 tons daily capacity at Lyons for a number of years. The State of New York has done more in granting assistance to this industry than any State in the Union. For years it paid a bounty of \$1 a ton on beets produced, divided between the factory and the farmers. It ceased doing this two years ago. The plant was compelled to exert strenuous efforts to secure sufficient beets. It is located in a district where special farm production has been the rule for a great many years. During the past season it was somewhat hampered in securing labor supply. Weather conditions were not of the best. The results for the season were discouraging.

OHIO.—The Continental Sugar Company has been operating a plant of 400 tons daily capacity at Fremont for a number of years. For several years it was quite difficult for this company to secure sufficient acreage of beets. It overcame this and constructed another plant at Blissfield, in southern Michigan. Both these plants prospered and worked up larger areas, until the company is now erecting two other factories, one at Paulding, and the other at Toledo, Ohio, to be in operation next year.

In the Fremont district the season opened with a wet and late spring. Some beets were planted as late as July. There was some injury due to hail and "grub worms," or white grubs.

In this district a new plow or implement for stirring the soil was introduced. It is a double-disk plow, which loosens the ground to a depth of 16 inches.

This plant has not yet installed a beet drier. Stock feeding is quite extensive in all parts of Ohio, and the pulp is fed to dairy cows and fattening cattle, sheep, and other animals. In the vicinity of the plant the stock industry is increasing quite rapidly.

A mixture of commercial fertilizers especially prepared for beet lands is used on the soil. Climatic conditions in the fields were favorable. There was a fair yield of beets of excellent quality.

OREGON.—The Amalgamated Sugar Company has been operating a factory of 400 tons capacity at La Grande for a number of years. In several localities conditions have been found to be well adapted to the beet-sugar industry, and this industry will be extended in the State in the near future. Transportation facilities are lacking in the parts showing the best indications. The factory at La Grande has experienced considerable difficulty in securing a sufficient acreage of beets. Improvement in this direction is gradual.

The weather was generally favorable throughout the season. There was trouble in some fields due to a small "white grub" and a leaf-hopper. The yield of beets was fair and the quality fairly good. However, results are not what they should be.

This plant is not drying its pulp. The entire output of the factory is consumed by local feeders, being mostly fed to cattle. No commercial fertilizers are used. Barnyard manure is applied to the extent of the supply.

WASHINGTON.—The Washington State Sugar Company is operating a factory of 500 tons at Waverly. It has had considerable difficulty in working up sufficient acreage to meet its requirements. The management has been gradually extending the beet-growing area to other localities in order to widen the scope of its possibilities. Formerly the beets were grown in districts where crops are produced by rainfall. Contracts are now taken in some of the districts where crops are grown by irrigation. By persistent efforts this plant has been able to increase its supply of beets.

Weather conditions this year were fair. The beet crop was rather more satisfactory than usual. The yield was somewhat light, but the quality was exceptionally good.

There are quite a number of places in Washington actively promoting the establishment of sugar plants. In several places companies have been organized and stock placed on the market only to be later held

up awaiting future developments. These enterprises, like many in other places, were influenced largely by uncertainty regarding tariff legislation. Now that this has been settled these contemplated beet-sugar enterprises are taking on new life and it is likely that other sugar factories will be established in the State in the near future. Some of these are located in districts requiring irrigation; others are in districts similar to the one at Waverly, where crops are grown by rainfall. The results of the past season of this plant were encouraging and renewed efforts are being made to further promote its interests.

STATISTICS OF THE SUGAR INDUSTRY.

Under this head I present (1) a table showing the beet-sugar factories established in the United States, with names of the owning companies and the daily capacities of the plants; (2) farm and factory results of the beet-sugar industry in the United States for 1909, with data for 1901-1908 for purposes of comparison; (3) the world's production of sugar, both cane and beet, for the years 1905-1909; and (4) data relating to the consumption of sugar in this country.

BEET-SUGAR FACTORIES IN THE UNITED STATES.

Table I comprises a complete list of the beet-sugar factories in this country, arranged by States, showing the official names of the manufacturing companies and the location of the factories. It also shows the daily slicing capacity of each factory expressed in tons of beets, and the aggregate slicing capacity of all the factories:

TABLE I.—*Beet-sugar companies and factories in the United States.*

ARIZONA.

Manufacturing companies.	Factory locations.	Number of factories.	Daily slicing capacity (tons of beets).
The Southwestern Sugar and Land Co.....	Glendale.....	1	800

CALIFORNIA.

Alameda Sugar Co.....	Alvarado.....	1	800
Los Alamitos Sugar Co.....	Los Alamitos.....	1	700
Spreckels Sugar Co.....	Spreckels.....	1	3,000
Union Sugar Co.....	Betteravia.....	1	600
American Beet Sugar Co. (Main office New York).....	Chino.....	1	900
	Oxnard.....	1	2,000
Pacific Sugar Corporation, Los Angeles.....	Visalia.....	1	400
	Corcoran.....	1	600
Sacramento Valley Sugar Co.....	Hamilton City.....	1	700
Southern California Sugar Co.....	Santa Ana.....	1	600
Total.....		10	10,300

TABLE I.—*Beet-sugar companies and factories in the United States*—Continued.

COLORADO.

Manufacturing companies.	Factory locations.	Number of factories.	Daily slicing capacity (tons of beets).
American Beet Sugar Co., Denver.....	(Rocky Ford.....	1	1,100
	Lamar.....	1	600
	Las Animas.....	1	700
Holly Sugar Co.....	Holly.....	1	600
Holly Construction Co.....	Swink.....	1	1,200
National Sugar Manufacturing Co.....	Sugar City.....	1	500
	Eaton.....	1	600
	Greeley.....	1	600
	Loveland.....	1	1,200
	New Windsor.....	1	600
The Great Western Sugar Co., Denver.....	Longmont.....	1	1,200
	Fort Collins.....	1	1,200
	Sterling.....	1	600
	Brush.....	1	600
	Fort Morgan.....	1	600
The Western Sugar and Land Co.....	Grand Junction.....	1	600
Total.....		16	12,500

IDAHO.

Utah-Idaho Sugar Co., Salt Lake City, Utah.....	(Idaho Falls.....	1	1,200
	Sugar.....	1	1,200
	Blackfoot.....	1	600
	Nampa ^a	1	750
Total.....		4	3,750

ILLINOIS.

Charles Pope, Chicago.....	Riverdale.....	1	350
----------------------------	----------------	---	-----

IOWA.

Iowa Sugar Co.....	Waverly.....	1	500
--------------------	--------------	---	-----

KANSAS.

United States Sugar and Land Co.....	Garden City.....	1	1,200
--------------------------------------	------------------	---	-------

MICHIGAN.

Michigan Sugar Co., Saginaw.....	(Bay City.....	1	600
	Caro.....	1	1,200
	Alma.....	1	750
	Carrollton.....	1	800
	Sebewaing.....	1	600
	Croswell.....	1	600
West Bay City Sugar Co.....	Bay City, W. S.....	1	600
Holland Sugar Co.....	Holland.....	1	350
Owosso Sugar Co., Bay City.....	(Owosso.....	1	1,200
	Lansing.....	1	600
German-American Sugar Co.....	Bay City, Station A (Salzburg). Mount Clemens.....	1	650
Mount Clemens Sugar Co.....	Menominee.....	1	600
Menominee River Sugar Co.....	St. Louis.....	1	600
St. Louis Sugar Co.....	Blissfield.....	1	600
The Continental Sugar Co., Cleveland, Ohio.....	Charlevoix.....	1	600
West Michigan Sugar Co.....			
Total.....		16	11,550

^a Not in operation in 1909.

TABLE I.—*Beet-sugar companies and factories in the United States*—Continued.

MINNESOTA.			
Manufacturing companies.	Factory locations.	Number of factories.	Daily slicing capacity (tons of beets).
Carver County Sugar Co.....	Chaska.....	1	600
MONTANA.			
The Great Western Sugar Co.....	Billings.....	1	1,200
NEBRASKA.			
American Beet Sugar Co.....	Grand Island.....	1	350
NEW YORK.			
Lyons Beet-Sugar Refining Co.....	Lyons.....	1	600
OHIO.			
Continental Sugar Co.....	Fremont.....	1	400
OREGON.			
Amalgamated Sugar Co.....	La Grande.....	1	400
UTAH.			
Amalgamated Sugar Co., Ogden	{ Logan.....	1	600
	{ Ogden.....	1	400
	{ Lewiston.....	1	600
Utah-Idaho Sugar Co., Salt Lake City.....	{ Lehi.....	1	1,200
	{ Garland.....	1	1,200
Total.....		5	4,000
WASHINGTON.			
Washington State Sugar Co., Spokane.....	Waverly.....	1	500
WISCONSIN.			
Wisconsin Sugar Co., Milwaukee.....	Menomonee Falls.....	1	500
Chippewa Sugar Co., Milwaukee.....	Chippewa Falls.....	1	600
Rock County Sugar Co.....	Janesville.....	1	600
United States Sugar Co.....	Madison.....	1	600
Total.....		4	2,300
Grand total.....		66	51,300

The total number of beet-sugar factories in the United States is 66, and of these 65 were in operation in 1909, 2 more than in 1907 and 3 more than in 1908. For the 66 factories the total daily capacity is 51,300 tons, and the average 777 tons.

California had 10 factories in operation, with a total capacity of 10,300 tons of beets daily, and an average of more than 1,000 tons each.

Colorado had 16 factories in operation, with a total capacity of 12,500 tons daily, and an average of 781 tons.

Michigan had in operation the same number of factories as Colorado, 16, but their capacity for working beets is a little less, the total being 11,550 and the average 722 tons daily.

Utah had 5 plants in operation, with capacities averaging 800 tons of beets daily.

Idaho has 4 beet-sugar plants, 3 of which were in operation in 1909. The total capacity of the 4 is 3,750 tons of beets daily, the average being 937 tons.

Wisconsin also has 4 factories, all of which were in operation in 1909. Their total capacity is 2,300 tons, the average being 575 tons.

Ten other States and one Territory (Arizona) had 1 factory each in operation, the total capacity being 6,900 tons, and the average 627 tons.

PRODUCTION OF SUGAR BEETS AND BEET SUGAR IN THE UNITED STATES.

In the preparation of these statistics I have depended as usual on the reports furnished by responsible officials of the various factories, as from no other source can the information be drawn. The figures furnished me are doubtless estimates, in some cases, especially the figures for acreage. In most cases, however, I believe the factory officials report the actual facts as revealed by their books of account. To requests for statistical data the factory officials have responded promptly and courteously. In order to avoid giving publicity to the business affairs of individual concerns I present only the totals and averages for each State having more than one factory, while the data for the eleven States having a single factory each have been combined.

ACREAGE OF BEETS PLANTED.

The acreage planted to sugar beets in the United States in 1909 and the percentage of this abandoned owing to unfavorable weather and other adverse influences are shown in Table II.

TABLE II.—*Acreage planted to beets in 1909.*

State.	Planted.	Aban- doned.	State.	Planted.	Aban- doned.
	<i>Acres.</i>	<i>Per cent.</i>		<i>Acres.</i>	<i>Per cent.</i>
California.....	93,267	11.0	Wisconsin.....	15,000	6.7
Colorado.....	136,882	11.0	Eleven other States.....	50,970	16.4
Idaho.....	16,086	4.1			
Michigan.....	120,175	6.6	The United States....	464,675	9.6
Utah.....	32,295	3.1			

As a few of the factories reported the acreage planted the same as that harvested, taking no account of acreage plowed up and planted to other crops, it is probable that the acreage planted and the percentage abandoned were slightly above the figures shown in Table II. These figures may, however, be taken as substantially correct. The acreage planted was 10 per cent above the highest previous record made in 1908, and the percentage abandoned was considerably smaller than in 1908.

SUMMARY OF FARM AND FACTORY RESULTS.

In Table III are presented the results achieved in the beet fields and factories of the United States for the season of 1909, and for purposes of comparison, the totals and averages by years for 1901-1908:

TABLE III.—General factory and farm results of the beet-sugar industry in the United States, 1901-1909.

BY STATES FOR 1909.

State and year.	Factories in operation.	Area harvested.	Average yield of beets per acre.	Beets worked.	Sugar manufactured.		Average extraction of sugar, based on weight of beets.	Average sugar in beets.	Average purity coefficient of beets. ^a	Average length of campaign.
					Pounds.	Tons. ^b	Per ct.	Per ct.		Days.
California.....	10	Acres. 83,000	Tons. ^b 10.63	Tons. ^b 882,084	254,544,000	127,272	14.43	17.61	83.62	102
Colorado.....	16	121,698	10.33	1,256,771	298,810,000	149,405	11.89	14.24	80.51	85
Idaho.....	3	15,434	10.60	163,557	39,988,000	19,994	12.22	15.98	86.17	83
Michigan.....	16	112,232	7.31	819,923	212,106,000	106,053	12.93	17.00	86.21	74
Utah.....	5	31,293	14.54	455,064	97,768,000	48,884	10.74	15.04	84.22	128
Wisconsin.....	4	14,000	10.21	143,000	34,340,000	17,170	12.01	15.88	85.17	63
States having but a single factory: ^c										
Arizona.....	11	42,605	8.47	360,983	87,382,000	43,691	12.10	15.09	83.21	61
Illinois.....										
Iowa.....										
Kansas.....										
Minnesota.....										
Montana.....										
Nebraska.....										
New York.....										
Ohio.....										
Oregon.....										
Washington.....										
Totals and averages ^d	65	420,262	9.71	4,081,382	1,024,938,000	512,469	12.56	16.10	84.11	83

^a By purity coefficient is meant the percentage of sugar in the total solids of the substance tested, whether it be beets, juice, or sirup. In this table it represents the average percentage of sugar in the total solids of the beets as determined by tests made at the factories.

^b Tons of 2,000 pounds each.

^c Grouped together to avoid giving publicity to data relating to individual factories.

^d The average yield of beets per acre is found by dividing the total beets worked by the total acreage harvested; the average extraction of sugar by dividing the total sugar produced by the total beets worked; the average contents of sugar, coefficients of purity, and length of campaigns by adding the figures reported by the different factories and dividing by the number of reporting factories.

TABLE III.—*General factory and farm results of the beet-sugar industry in the United States, 1901-1909—Continued.*TOTALS AND AVERAGES BY YEARS, 1901-1908.^a

State and year.	Factories in operation.	Area harvested.	Average yield of beets per acre.	Beets worked.	Sugar manufactured.		Average extraction of sugar, based on weight of beets.	Average sugar in beets.	Average purity coefficient of beets.	Average length of campaign.
		<i>Acres.</i>	<i>Tons.^b</i>	<i>Tons.^b</i>	<i>Pounds.</i>	<i>Tons.^b</i>	<i>Per ct.</i>	<i>Per ct.</i>		<i>Days.</i>
1908.....	62	364,913	9.36	3,414,891	851,768,000	425,884	12.47	15.74	83.5	74
1907.....	63	370,984	10.16	3,767,871	927,256,430	463,628	12.30	15.8	83.6	89
1906.....	63	376,074	11.26	4,236,112	967,224,000	483,612	11.42	14.9	82.2	105
1905.....	52	307,364	8.67	2,665,913	625,841,228	312,921	11.74	15.3	83.0	77
1904.....	48	197,784	10.47	2,071,539	484,226,430	242,113	11.69	15.3	83.1	78
1903.....	49	242,576	8.56	2,076,494	481,209,087	240,604	11.59	c15.1	(d)	75
1902.....	41	216,400 ^e	8.76	1,895,812	436,811,685	218,406	11.52	c14.6	c83.3	94
1901.....	36	175,083	9.63	1,685,689	369,211,733	184,606	10.95	14.8	82.2	88
Averages, 1901-1908.....		281,397	9.70	2,726,790	642,943,574	321,472	11.76	15.2	83.1	85

^a Compiled from the annual reports on Progress of the Beet-Sugar Industry in the United States for the years named.^b Tons of 2,000 pounds each.^c These averages are not based on data for all the factories, as some of them failed to report results of tests, but it is believed that they fairly represent the character of the total beet crops.^d No data reported.^e Based on reports from 27 factories and careful estimates for 14 others.

In the following discussion of the data for 1909 and earlier years it should be noted that round numbers have been freely used, and that only the short ton (2,000 pounds) has been employed.

ACREAGE OF BEETS HARVESTED.

The total area of beets harvested in 1909 was 420,262 acres. This area is 55,000 acres (15 per cent) greater than the area harvested in 1908, 44,000 (12 per cent) greater than in 1906 (the highest previous record), and 139,000 (nearly 50 per cent) greater than the yearly average for the eight years 1901-1908.

In California 83,000 acres of beets were harvested, or 20,700 acres (32 per cent) more than in 1908, the highest previous record. The greatest area harvested for a single plant was 16,000 acres, which is the highest figure for the entire country. The average per factory was 8,300 acres.

In Colorado 121,698 acres of beets were harvested, which is slightly greater than the acreage of 1908, and 6,000 acres less than the acreage of 1907. The average area per factory in 1909 was 7,600 acres.

In Michigan 112,232 acres of beets were harvested, which is 31,000 (32 per cent) more than in 1908, and 18,000 (nearly 20 per cent) more than the highest previous record, made in 1906. The average per factory was 7,000 acres.

In Utah 31,293 acres of sugar beets represent the harvested area for 1909, practically the same area as that of 1908, and nearly 3,000

acres (9 per cent) more than the highest acreage for any earlier year, that for 1907. The average per factory was 6,258.

In Idaho the area harvested for the three factories in operation was 15,434 acres, which was 5,600 (26 per cent) less than the 1908 acreage and more than 10,000 acres (40 per cent) less than the 1907 acreage. In fact 1909 appears to have been an off year for the industry in Idaho. The average per factory was 5,149 acres.

In Wisconsin 14,000 acres of beets were harvested in 1909, practically the same area as in 1905 and 1908, but 1,560 acres (10 per cent) less than in 1906, the record year for the State. The average for 1909 was 3,500 acres per factory.

In the eleven States in each of which a single factory is located, 42,605 acres of beets were harvested, an average of 3,873 acres per factory. These figures, when compared with those for earlier years, indicate that on an average the industry is just about holding its own in these States.

TONNAGE OF BEETS PRODUCED.

For the campaign of 1909 (which in case of a few factories extended over into 1910) the officials of the 65 plants in operation report a total of 4,081,382 tons of beets worked. This is greater by 666,000 tons (19 per cent) than the total tonnage for 1908. It is also greater by 8 per cent than the tonnage for 1907; but it falls below the record tonnage for 1906 by nearly 155,000 tons, or $3\frac{2}{3}$ per cent. Compared with the average yearly tonnage for 1901-1908, the total production of beets for 1909 is higher by nearly 50 per cent.

The average quantity of beets worked by the 65 factories in 1909 was 62,790 tons.

The average yield of beets per acre in 1909 was 9.71 tons, a figure which, since 1900, has been exceeded only three times—in 1904, 1906, and 1907. In 1906 the record yield of 11.26 tons per acre exceeded that of the past year by nearly 16 per cent. The yield for 1909 is a trifle above the average for 1901-1908.

In California the total yield for 1909 was 882,084 tons of beets, which exceeds California's highest previous record by 31 per cent. The yield per acre was 10.63 tons, a figure considerably above the averages for 1905, 1907, and 1908, but exceeded by those of 1904 and 1906.

In Colorado the aggregate yield for 1909 was 1,256,771 tons, and the average per acre 10.33 tons. This total was greater by 13 per cent than the corresponding figure for 1908, but less by 17 per cent than the record yield of 1,523,000 tons in 1907. The yield per acre, though high, was below those of 1904, 1906, and 1907.

The total quantity of beets delivered to factories in Michigan was 819,923 tons. The yield per acre, however, was only 7.31 tons.

Though Michigan's acreage was 35 per cent higher than that of California, her production was $7\frac{1}{2}$ per cent lower. Michigan's crop for 1909, however, exceeded that for 1908 by nearly 209,000 tons (34 per cent), and the record crop of 1906 by nearly 2 per cent. The yield per acre was lower than in any recent year except 1905, when it fell below 7 tons.

Utah's beet crop for 1909 was phenomenal, the total being 455,000 tons and the average per acre 14.54 tons, a figure which exceeds all records for the United States except that of 15.88 tons per acre made by this State in 1906. Utah's tonnage per acre for 1909 exceeds the average for the whole country by 50 per cent. The total yield for the year exceeds that of 1908, the highest previous record, by 14 per cent.

Idaho's beet crop for 1909 aggregated 163,557 tons, the average yield per acre being 10.60 tons. While the total crop was less than in any year since 1905, being 33 per cent below the record yield of 1907, the tonnage per acre was slightly above the average for the State, and nearly 10 per cent above the average for the whole country.

In Wisconsin the growers delivered to the factories 143,000 tons of beets, the average yield per acre being 10.21 tons. The total exceeded that of any preceding year except 1906, when it was greater by nearly 11 per cent. The yield per acre was slightly above the average for the State, though it was less than in 1904 and 1907. It exceeded the general average for the United States by more than 5 per cent.

The eleven factories located in Arizona, Illinois, Iowa, Kansas, Minnesota, Montana, Nebraska, New York, Ohio, Oregon, and Washington worked 360,983 tons of beets, the average yield being 8.47 tons of beets per acre. The average yield for these States has for a number of years fallen considerably under the general average for the country; this year it is less by nearly 13 per cent.

QUALITY OF BEETS PRODUCED.

Tests are applied to beets used in the manufacture of sugar, to determine (1) the percentage of sugar in the beet and (2) the percentage of sugar in the total dry matter of the beet; i. e., in the beet minus its water content. The results are commonly referred to as "sugar content" and "purity." Both have an important influence in determining the amount of sugar which may be extracted from a given weight of beets. In both respects the beet crop of 1909 reached a "high-water mark." The average sugar content of the 1909 crop was 16.1, which is nearly 2 per cent above the highest previous average, that of 1907, and nearly 6 per cent above the average for 1901-1908.

The highest state averages were 17.61 per cent in California and 17 in Michigan, and the lowest 14.24 per cent in Colorado.

The average coefficient of purity for the whole country in 1909 was 84.11, the highest previous record being 83.6 in 1907. The purity for 1909 was about 1 per cent above the eight-year average.

The Michigan and Idaho beet crops showed the highest purity, 86.21 and 86.17, respectively.

PRODUCTION OF BEET SUGAR IN 1909.

The production of beet sugar in the United States resulting from the beet crop of 1909 reached a total of 512,469 tons, a production exceeding that of 1908 by more than 20 per cent and the record figure of 1906 by 6 per cent. It is more than double the production of 1904 and nearly 60 per cent above the average for 1901-1908. The increase in production resulted in part from the increased acreage already referred to and in part from improved quality of the beets and increased factory efficiency which will be discussed farther on.

The California factories produced in 1909 a total of 127,272 tons of sugar, or 30 per cent more than in 1906, when the highest previous record was made.

The Colorado factories produced 149,405 tons of sugar in 1909, which was 22 per cent more than in 1908, but 12 per cent less than in 1907 and 11 per cent less than in 1906.

In 1909 Idaho produced nearly 20,000 tons of sugar, only 3 of her 4 factories being in operation. This figure is 47 per cent below that for 1907 and decidedly below the totals for 1906 and 1908.

Michigan's 16 factories in 1909 turned out 106,053 tons of sugar, exceeding the highest product for any previous year—that for 1906—by nearly 20 per cent.

Utah's sugar product in 1909 was nearly 49,000 tons, or $4\frac{2}{3}$ per cent more than the total for 1908, in which year the highest previous record was made.

Wisconsin's yield of beet sugar in 1909 was 17,170 tons, or a little less than in 1906 and 1908, and 12 per cent less than in 1907.

The 11 other factories standing singly in other States in 1909 produced 43,691 tons of beet sugar.

RELATIVE MAGNITUDE OF THE INDUSTRY IN DIFFERENT STATES.

California, with $15\frac{1}{3}$ per cent of the factories and 20 per cent of the factory capacity in the United States, had, in 1909, $19\frac{3}{4}$ per cent of the beet acreage and produced $21\frac{3}{8}$ per cent of the beet tonnage and nearly 25 per cent of the beet sugar.

With $24\frac{1}{2}$ per cent of the factories and $24\frac{1}{3}$ per cent of the factory capacity of the entire country, Colorado in 1909 had nearly 29 per

cent of the beet acreage, nearly $30\frac{4}{5}$ per cent of the beet tonnage, and 29 per cent of the beet-sugar product.

With 6 per cent of the factories and $7\frac{1}{3}$ per cent of the factory capacity, Idaho in 1909 had $3\frac{2}{3}$ per cent of the beet acreage, 4 per cent of the beet tonnage, and nearly 4 per cent of the beet sugar.

With $24\frac{1}{4}$ per cent of the factories and $22\frac{1}{2}$ per cent of the factory capacity, Michigan in 1909 had nearly $26\frac{3}{4}$ per cent of the beet acreage, 20 per cent of the beet tonnage, and nearly 21 per cent of the beet sugar produced.

With $7\frac{3}{5}$ per cent of the factories and $7\frac{4}{5}$ per cent of the factory capacity, Utah in 1909 had nearly $7\frac{1}{2}$ per cent of the beet acreage, more than 11 per cent of the beet tonnage, and $9\frac{1}{2}$ per cent of the beet sugar produced.

With 6 per cent of the factories and $4\frac{1}{2}$ per cent of the factory capacity, Wisconsin in 1909 had $3\frac{1}{3}$ per cent of the beet acreage, $3\frac{1}{2}$ per cent of the beet tonnage, and $3\frac{1}{3}$ per cent of the total sugar product.

The 11 other States having 1 factory each, with $16\frac{2}{3}$ per cent of the factories and $13\frac{1}{2}$ per cent of the factory capacity, in 1909 had 10 per cent of the beet acreage, nearly 9 per cent of the beet tonnage, and $8\frac{1}{2}$ per cent of the beet-sugar yield.

EXTRACTION OF SUGAR.

The extraction of sugar by the factories depends (1) on the quality of the beets as indicated by their sugar content and purity and (2) on the efficiency of the means and methods employed in the factories. The average per cent of sugar extracted in 1909 was 12.56; in other words, from 100 pounds of beets 12.56 pounds of sugar were extracted on an average. The highest previous average was 12.47 per cent in 1908, and the average for the eight-year period 1901-1908 was 11.76.

A comparison of the extraction with the percentage of sugar in the beets shows that in 1909 on an average the factories failed to secure 3.54 pounds of sugar for every 100 pounds of beets worked. The corresponding figures for earlier years are 3.27 pounds in 1908, 3.50 in 1907, 3.48 in 1906, 3.56 in 1905, 3.61 in 1904, 3.51 in 1903, 3.02 in 1902, and 3.85 in 1901. The average for the five years 1901-1905 was 3.52 pounds; for the four years 1906-1909 it was 3.47 pounds.

The importance of these losses appears more strongly when viewed as percentages of the total sugar in the beets. It appears that in 1909 the factories only succeeded in transforming into commercial refined sugar 78 per cent of the sugar originally existing in the beet crop, the other 22 per cent either remaining in the beet pulp or in

the form of uncrystallizable sugar in the molasses by-product. The corresponding average figures for the five-year period 1901-1905 are 76.6 and 23.4 per cent; and for the four-year period 1906-1909, 77.8 and 22.2.

The foregoing figures indicate that the increased product of sugar per ton of beets has resulted mainly from improvement in quality of beets, though it has been materially helped by increased efficiency of means and methods employed in the factories.

PRODUCT OF SUGAR PER ACRE AND PER TON OF BEETS.

The following instructive table, which has no counterpart in previous reports of this series, shows the yield of sugar per acre of beets harvested and per ton of beets worked in the different States, and for purposes of comparison the averages for the United States by years over the period beginning with 1901:

TABLE IV.—*Yield of sugar per acre of beets harvested and per ton of beets worked by States for 1909 and by years for 1901-1909.*

State and year.	Yield of sugar from—		State and year.	Yield of sugar from—	
	An acre of beets.	A ton of beets.		An acre of beets.	A ton of beets.
1909.	<i>Tons.</i>	<i>Pounds.</i>	The United States—Cont'd.	<i>Tons.</i>	<i>Pounds.</i>
California.....	1.5335	288.6	1906.....	1.2859	228.3
Colorado.....	1.2277	237.8	1906-1909.....	1.2306	243.3
Idaho.....	1.2955	244.5	1905.....	1.0181	234.8
Michigan.....	1.9449	258.7	1904.....	1.2241	233.8
Utah.....	1.5621	214.8	1903.....	.9919	231.7
Wisconsin.....	1.2264	240.1	1902.....	1.0093	230.4
Other States.....	1.0265	242.1	1901.....	1.0544	219.0
The United States:			1901-1905.....	1.0522	230.6
1909.....	1.2194	251.1			
1908.....	1.1671	249.4			
1907.....	1.2497	246.1			

The average yield of sugar per acre of beets for the whole country in 1909 was a little more than 1½ tons (about 1.22). The highest state averages were 1.56 in Utah and 1.53 in California. In Michigan considerably less than 1 ton of sugar per acre was produced and in the States with single factories the average was but a trifle over 1 ton. The averages for the other States do not vary widely from the general average for the year.

In the yield of sugar per ton of beets California heads the list with 288.6 pounds, owing to the very superior quality of her beet crop, and Michigan stands second with 258.7 pounds for the same reason. There is a lack of correspondence between the yields of sugar per acre and per ton of beets, which is to be expected, since the yield of sugar per ton of beets depends mainly on the quality—sugar content and purity—of the beets, while the yield of sugar per acre depends on

this same factor together with the yield of beets per acre, the latter often proving the more important factor. There often appears a tendency for the one to rise as the other falls, because a season favorable to luxuriant growth and a large yield of beets is usually unfavorable to high sugar content and purity. It will be noticed, for instance, that Utah with the highest yield of sugar per acre has the lowest yield per ton of beets, while Michigan with the lowest yield per acre has the highest yield per ton of beets with one exception, that of California. But this tendency is by no means uniform, since superior quality not infrequently accompanies a heavy yield of beets. This is illustrated by California, whose yield of sugar per acre is next to the highest, while her yield of sugar per ton of beets is markedly higher than that of any other State.

The general averages for earlier years given in Table III show that substantial progress has been made toward higher yields of sugar. They show that the highest yield of sugar per ton of beets (251 pounds) occurred in 1909 and the highest yield per acre (1.286 tons) in 1906, while the lowest yield per ton (219 pounds) occurred in 1901 and the lowest yield per acre (0.99 ton) in 1903. The average yield of sugar per ton of beets for the five years 1901–1905 was 230.6 pounds, and for the four years 1906–1909, 243.3 pounds, a substantial increase; and the average yields of sugar per acre for the same periods were 1.05 tons for 1901–1905 and 1.23 tons for 1906–1909, an increase of more than 17 per cent.

LENGTH OF CAMPAIGNS.

In 1909 the 65 beet-sugar factories were in actual operation—manufacturing sugar from beets—83 days on an average. The 5 Utah factories made campaigns averaging 128 days. The 10 California factories averaged 102 days. In Colorado the average was 85 and in Idaho 83. Elsewhere the campaigns were below the general average.

The highest record for average length of campaign in the United States, made in 1906, was 105 days, or 22 days above that of 1909. The average for the past campaign was below those of 1901, 1902, and 1907, and two days below the average for the eight-year period 1901–1908.

A beet-sugar plant can not begin operations until beet harvesting is under way in its producing district; hence the opening of the campaign depends upon the climatic conditions which determine the time of maturity of the beet crop. The closing of the campaign also is more or less dependent on climatic conditions, since freezing weather necessitates protection for the beets, thus materially increasing their cost to the factory. Aside from climatic conditions, the factor determining the length of campaign for a beet-sugar plant is

the ratio existing between its daily capacity and the total tonnage of beets it has to work. A plant capable of working 500 tons of beets daily with a total crop of 50,000 tons of beets to work should make a campaign of 100 days. If conditions are unfavorable or the beet crop is short a factory may not work up to its rated capacity. On the other hand, with a heavy tonnage of beets to work and favorable conditions, a factory may exceed its rated capacity.

The reports from the factory officials indicate that about 25 of the 65 factories in operation equaled or exceeded their rated beet-working capacities during their 1909 campaign. The 10 factories in California reached 85 per cent of their full capacity. The 16 Colorado factories exceeded their rated capacity on an average. The 3 Idaho factories only reached 60½ per cent of their capacity. The 16 Michigan factories used 96 per cent, the 5 Utah factories 90 per cent, and the 4 Wisconsin factories 95 per cent of their beet-working capacity; and the 11 factories located in other States averaged 83 per cent. The 65 factories in operation in 1909 employed an average of 94.6 per cent of the capacity with which they are credited.

The foregoing figures relate to the work of the factories only during their days of operation. It must not be assumed that, because the factories have run almost up to their rated capacity for working beets, little further extension of the industry can be expected without enlarging the capacity of these plants or building new ones. Such is by no means the case, since by longer campaigns a large extension is possible. It is evident that a large majority of these factories, if not all, can make much longer campaigns if they can secure ample supplies of beets. An average campaign exceeding that of 1909 by 25 per cent was made in 1906, and there appears no good reason for doubting that the record of 1906 can be greatly exceeded.

THE WORLD'S PRODUCTION OF SUGAR.

In Table V is shown the world's production of sugar, so far as statistically reported, for the years 1905-1909. While the grand total for 1909 is almost the same as in 1906 and 1908, the production of cane sugar shows a tendency to increase during the five-year period, while the production of beet sugar shows a tendency to decrease. In 1905 the total sugar produced from beets exceeded the total from cane by 7 per cent. In 1909 the total from cane exceeded that from beets by 18 per cent.

TABLE V.—*Sugar production of the world, 1905-1909.^a*

Country.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.
CANE SUGAR.					
United States:	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Louisiana and Texas.....	348,752	243,000	352,000	370,000	335,000
Hawaii.....	383,225	392,871	465,288	477,817	490,000
Porto Rico.....	213,000	210,000	200,000	245,000	280,000
Total United States ^b	944,977	845,871	1,017,288	1,092,817	1,105,000
Cuba.....	1,178,749	1,427,673	961,958	1,513,582	1,700,000
Other West Indies.....	302,163	275,257	255,639	256,061	316,000
Mexico.....	107,529	119,496	123,285	125,000	130,000
Central America.....	18,516	19,747	19,258	21,000	21,000
South America.....	700,001	628,777	540,518	694,655	684,000
Total America.....	3,251,935	3,316,821	2,917,946	3,703,115	3,956,000
Asia.....	2,926,209	3,443,794	3,421,827	3,353,685	3,260,000
Africa.....	317,967	326,825	284,870	318,992	395,000
Oceania.....	230,000	249,000	280,725	231,098	217,328
Europe.....	15,722	16,400	11,000	20,000	16,000
Total cane-sugar production.....	6,741,833	7,352,840	6,916,368	7,626,890	7,844,328
BEET SUGAR.					
United States.....	279,393	431,796	413,954	380,254	457,562
Canada.....	11,419	11,367	7,943	6,964	8,802
Total America.....	290,812	443,163	421,897	387,218	466,364
Europe:					
Germany.....	2,418,156	2,239,179	2,129,597	2,080,000	2,040,000
Austria-Hungary.....	1,509,789	1,343,940	1,424,657	1,398,000	1,260,000
France.....	1,089,684	756,094	727,712	802,000	825,000
Russia.....	968,500	1,440,130	1,410,000	1,265,000	1,150,000
Belgium.....	328,770	282,804	232,352	258,000	250,000
Netherlands.....	207,189	181,417	175,184	214,000	200,000
Other countries.....	410,255	467,244	462,772	500,000	460,000
Total Europe.....	6,932,343	6,710,808	6,562,274	6,517,000	6,185,000
Total beet-sugar production.....	7,223,155	7,153,971	6,984,171	6,904,218	6,651,364
Total cane and beet sugar.....	13,964,988	14,506,811	13,900,539	14,531,108	14,495,692

^a In long tons of 2,240 pounds, except in the case of European beet-sugar production, which has been retained in metric tons of 2,204.622 pounds, as estimated by Licht. United States beet-sugar data were obtained from reports on the Progress of the Beet-Sugar Industry in the United States; other data from official statistics of various countries, and from Willett & Gray.

^b Not including the Philippine Islands, which are included under Asia.

CONSUMPTION OF SUGAR IN THE UNITED STATES.

The consumption of sugar in the United States has steadily increased for a long period of years. The supply for 1909 was made up of the domestic production of beet sugar and cane sugar, the surpluses of the cane sugar produced in Hawaii and Porto Rico, about one-third of the Philippine product, a very heavy importation from Cuba, and considerable quantities produced in other foreign countries.

CONSUMPTION OF SUGAR PER CAPITA.

Table VI, compiled from the publications of Willett & Gray, shows the consumption of sugar per capita in the United States for a period of twenty-six years:

TABLE VI.—Consumption of sugar per capita in the United States, 1884–1909.

Year.	Pounds.	Year.	Pounds.	Year.	Pounds.	Year.	Pounds.
1884	51.00	1891	67.46	1898	60.30	1905	76.50
1885	49.95	1892	63.76	1899	61.00	1906	76.10
1886	52.55	1893	63.83	1900	66.60	1907	77.54
1887	53.11	1894	66.64	1901	69.70	1908	81.17
1888	54.23	1895	64.24	1902	72.80	1909	81.80
1889	52.64	1896	60.90	1903	70.90		
1890	54.56	1897	63.50	1904	75.30		

TOTAL CONSUMPTION OF SUGAR AND SOURCES OF SUPPLY.

The total consumption of sugar in the United States in 1909 was 3,648,579 short tons. The supply was derived from the sources shown in Table VII.

TABLE VII.—Sources of supply of sugar consumed in the United States in 1909.^a

Sources of supply.	Short tons.	Per cent of total.
Home production:		
Beet sugar.....	486,080	13.32
Cane sugar (Louisiana and Texas).....	459,155	12.58
Maple sugar.....	12,320	.34
Total home production.....	957,555	26.24
Hawaii ^b (cane).....	541,712	14.85
Porto Rico ^b (cane).....	263,331	7.22
Philippines ^c (cane).....	52,420	1.44
Cuba ^d (cane).....	1,598,835	43.82
Other foreign sources ^e (nearly all cane).....	234,726	6.43
Total domestic and foreign.....	3,648,579	100.00

^a According to Willett & Gray, except that long tons of 2,240 pounds have been reduced to short tons of 2,000 pounds.

^b Sugar from Hawaii and Porto Rico is admitted free of duty.

^c Under the old tariff law sugar from the Philippines paid a duty 25 per cent below the rate on foreign sugar. Under the new tariff law of August 5, 1909, sugar from the Philippines, up to 300,000 tons (long) in any year, will be admitted free.

^d Under the reciprocity treaty of December 11, 1902, sugar from Cuba is admitted at 20 per cent below the regular rate of duty.

^e This contains 10,232 tons of sugar made in the United States from foreign molasses.

It appears from the table that (in round numbers) $13\frac{1}{3}$ per cent of the sugar consumed in the United States in 1909 was beet sugar produced in this country, $12\frac{3}{8}$ per cent was cane sugar from Louisiana and Texas, and one-third of 1 per cent was domestic maple sugar; and that $26\frac{1}{4}$ per cent of all the sugar consumed was produced at home. If we add to this total the sugar brought in from insular possessions of the United States, we find that $49\frac{3}{4}$ per cent, or practically one-half, of the sugar consumed in this country was produced in the

United States and its possessions. About seven-eighths of the other half came from Cuba.

As the sugar produced in 1909 will constitute the great bulk of the supply for 1910, it is easy to foresee that considerable changes will occur in the relative proportions of the supply for 1910 from the several sources. As the 1909 production of beet sugar in the United States exceeds that of 1908 by 20 per cent, it is safe to forecast that more than 14 per cent of the sugar consumed in 1910 will be domestic beet sugar. As the 1909 production of cane sugar in Hawaii and Porto Rico showed increases of $2\frac{1}{2}$ and 14 per cent, respectively, it can be safely estimated that a larger percentage of our supply will come from these sources. The free admission of Philippine sugar should greatly increase the percentage coming from that source. On the whole, it is safe to predict that considerably more than one-half of the sugar consumed in this country in 1910 will be the product of the United States, including its island possessions.

PLANS AND PROSPECTS FOR EXTENDING THE BEET-SUGAR INDUSTRY IN THE UNITED STATES.

GENERAL SURVEY OF THE SITUATION.

As the beet-sugar industry in the United States develops interest in it grows and its importance in the business affairs of the country becomes greater. The establishment of beet-sugar factories is now proceeding logically. The men who invest money in factories must feel satisfied that required conditions are present before proceeding to establish plants. It was through failure to follow this rule that early mistakes were made in establishing the beet-sugar industry. Desire to "boom" towns and undue enthusiasm for the new industry led to several mistakes. Little was known of the suitability of the lands for beet growing and less was known of the methods of cultivation required. People acted on impulse rather than sound business principles. Farmers were ready to contract for acreage; capitalists were ready to furnish the money. A sugar factory was built and requirements were studied afterwards. In some cases success followed, but in other cases it became evident that mistakes had been made. In a number of cases the factories eventually closed down, and the machinery was removed to other places where conditions were more promising.

In the earlier period of development of this industry some of the practices indulged in did not make for permanent success. For instance, bounties were offered by both the States and municipalities. Local communities gave bonuses; sites were voted by the people, often including smaller or larger tracts of farm land. These bounties and bonuses acted as an artificial stimulus, but they did not

promote permanent success. A sugar factory is a plain business proposition. It should rest entirely upon its merits. This should be thoroughly understood.

Too great haste in establishing factories led to jealousies and controversies where hearty cooperation was absolutely essential. Where the farmers of a particular district were accustomed to growing a particular crop, such as potatoes, cabbage, peppermint, broom corn, or tobacco, they were very apt to discourage beet growing. Factory promoters in some cases failed to make satisfactory arrangements with the railroads, and the roads were indisposed to meet the needs of the new industry, which required additional facilities, such as side-tracks, switches, and freight houses, besides beet dumps in the country sometimes where there were no stations. Prior to the establishment of a sugar factory agreements should be entered into with the railroads for special rates for transportation of beets and for supplying all needed facilities.

Another difficulty was lack of mutual confidence and hearty cooperation between the farmers and the factory. They did not work, think, or act together. The farmers regarded themselves as apart from the factory, a separate and distinct feature of the industry. They were suspicious and held aloof too much from the factory management. Often the managers of the factory were unfamiliar with the needs and sentiments of the farmers and did not display a proper spirit toward them. They were too assertive and not conciliatory enough.

Lack of labor was another serious obstacle. No farming community possessed a supply greater than was needed to meet existing demands of the farmers, and usually it was hardly sufficient for that. After the installation of the factory this problem of labor for the purpose of growing sugar beets was often attacked in an unsystematic manner. Often the new factory district drew on other factory districts, depleting their supply.

The farmer's interest in the industry scarcely extended beyond his own fields. He had not acquired a zeal for the industry as a whole. His ideas were meager and his interest temporary. If he planted beets and they were not profitable, he could turn to other crops.

These were a few of the difficulties encountered by the beet-sugar industry, but they have largely disappeared, and other influences have tended to alleviate the situation. Irrigation facilities have greatly increased and improved throughout the intermountain and coast States. Since the advent of the beet-sugar industry the national reclamation act has been passed by Congress. Under the provisions of this act the money received from the sale of public lands is expended in the development of irrigation. The Government becomes the

financier of these projects, furnishing the capital for their building and maintenance. It has greatly advanced reclamation of government and private lands. It offers an especial incentive to the extension of the beet-sugar industry. It not only capitalizes, but it directs the development of these irrigation facilities. Some of these irrigation projects cost several million dollars. The cost of any of them is too great for ordinary private capitalization. The Government practically loans the money. Where private lands are benefited the owner, through long-time annual payments with low interest, reimburses the general irrigation fund. The reclaimed public lands are sold on long payments at low interest. The price put upon them includes a sufficient amount to pay the pro rata share of cost chargeable to these lands for construction of ditches and reservoirs and their maintenance. Both the private holder of land and the one acquiring under the Government will eventually pay all these charges. The owners will then possess desirable lands with admirable permanent irrigating facilities. The effects of this reclamation act are far-reaching and highly beneficial to the country. The beet-sugar industry is one of the main beneficiaries, as it is well adapted for the development of these new areas.

Farmers have discovered that sugar beets offer an additional crop for the cycle of rotation adapted to any locality. Since it requires intense cultivation, it is preferable to many other crops for rotation purposes. It leaves the land cleaner and the soil in better condition. Most farmers who have grown beets for a considerable time will now admit that beet lands are very much improved for general purposes; that the yields are steadily increasing. This is especially true in the tobacco districts of Wisconsin, and the potato districts of Colorado, Utah, Montana, and California, and the cabbage, peppermint, and broom-corn districts of New York.

The animal industries throughout the country where beets are grown and sugar manufactured are especially affected. Beets and the by-products from the factory tend to promote these industries. They aid the dairyman, the feeder, and the breeder. They encourage greater production of stock. They aid in the maintenance of the soil through augmenting the supplies of barnyard manure.

The labor supply increases annually. We are training large numbers of laborers in field and factory and attracting trained foreign laborers as our industry becomes better known to the laborers of Europe who contemplate emigration.

There are many communities in the United States actively considering the installation of this industry. There has been a general awakening all along the line. My impression is that many of these plans and prospects will crystallize into definite favorable results in the near future. I give here reports from correspondents located in a large number of such communities throughout the country.

CALIFORNIA.

PERRIS CAL., *January 3, 1910.*

DEAR SIR: No sugar beets have yet been grown here commercially. Last summer the Columbia Land and Sugar Company came here and solicited subscriptions from the people for the establishment of a factory. Something like \$12,000 or \$14,000 was subscribed and a portion paid in. With that sum a factory site of 80 acres was purchased, and since then the company has been trying to finance the enterprise.

Sugar beets tried in an experimental way seem to do very well here, but none are now being grown.

Yours, truly,

H. M. HARFORD.

STOCKTON CHAMBER OF COMMERCE,

Stockton, Cal., January 14, 1910.

DEAR SIR: Sugar beets were formerly grown in this section for the sugar factories near San Francisco Bay, but their production was abandoned a number of years ago because of dissatisfaction on the part of the growers with the character of labor they had to employ and with indefinite returns from their production.

In fact, our landowners do not look with very much favor on the sugar-beet industry, and attempts to interest them during the last year in the establishment of a beet-sugar factory here were not successful.

As a matter of fact, such large returns are now received in the production of choice food products—such as celery, asparagus, beans, onions, and potatoes—on our peat lands and sediment lands that there is no disposition to enter the beet-growing industry.

Very truly, yours,

J. M. EDDY, *Secretary.*

IDAHO.

TWIN FALLS, IDAHO, *January 14, 1910.*

DEAR SIR: Three parties—W. S. Starr, of Kimberly; F. E. Johnson, of Murtaugh, and Alex McPherson, of Twin Falls—have each raised an acre of sugar beets. This was done merely as an experiment to determine the possibilities of this locality. The yields ranged from 20 to 23 tons per acre. The sugar contents were from 18 to 22 per cent and the purity from 84 to 92. The beets were analyzed by the chemists from the Idaho Sugar Company at Nampa and at Sugar City. Our experience has shown that sugar beets do not do well on raw sagebrush land, which gives a low tonnage and a low sugar content. Our best results were from land where the alfalfa had been turned under. It gave a good yield and a high sugar content. The experiment has shown that the approximate cost per acre of raising sugar beets in this locality is \$36.70. What beets were raised were sold at \$4.50 per ton. About 40 people in all tried raising sugar beets.

The time may come when conditions will be ripe here for a beet-sugar factory. However, as we understand the situation, such a gigantic movement is impracticable now for the reason that alfalfa hay is too high. The farmers will not raise sugar beets as long as they can raise alfalfa hay and get from \$6 to \$14 per ton for it.

Yours, very truly,

TWIN FALLS COMMERCIAL CLUB,
Per J. F. STOLTZ, *Secretary.*

INDIANA.

CRAWFORDSVILLE, IND., *January 3, 1910.*

DEAR SIR: I have been under the employment of Benjamin Boutell, of Bay City, Mich., for the last year on beet experiments in Montgomery County, Ind.

Sixty farmers last spring planted one-fourth acre of beets each from seed furnished by my client. The beets were planted a month late, but the crop was very satisfactory. The first test made, about sixty days after planting, averaged 12.3 per cent. The beets tested when delivered at the factory in Bay City about 16 per cent sugar and about 90 purity. The cost of production was about \$18 per acre. The yield averaged 18 tons per acre; but with beets planted early in May we can easily make an average of 20 tons per acre.

Central Indiana, in my opinion and the opinion of sugar-beet experts, is one of the best sugar-beet sections in the world. In addition to this, we have cheap fuel, the best of transportation facilities, and plenty of water; and I would be very much pleased if the Government could interest our farmers in making further experiments in beet culture.

My people, who desire to build a factory here and who have been spending considerable money, are endeavoring to get the farmers to plant next year from 1 to 5 acres each and, if our factory is not started by that time, to ship the beets to the factories in Michigan, which can be done for \$1 per ton. We could have had our factory up and ready for this year's crop, but the farmers as yet have not shown enough interest to justify us in building the plant.

We are now giving away free samples of beet sugar manufactured from beets raised in this county this past year.

I desire to address several of our farmers' institutes in this county during the winter, and if you would mail me some reports of the Government on the sugar industry of our country I would appreciate the favor very much.

Very respectfully,

WM. M. REEVES.

MINNESOTA.

OWATONNA, MINN., *January 10, 1910.*

DEAR SIR: Our association was organized for the purpose of promoting the sugar-beet industry, for which we know our district to be exceptionally well adapted. For the season of 1909 we rented and planted in sugar beets a 40-acre field. On a small scale, from 1 to 5 acres and more, sugar beets were grown by about 80 farmers in this section, amounting in all to some 300 acres. All beets were grown under the supervision of the secretary of our association, who is a professional beet-sugar man. Our 40-acre experimental field yielded almost exactly 12 tons per acre; the small fields, running from 8 to 20 tons, averaged between 12 and 13 tons per acre. The average sugar content was about 14 per cent; coefficient of purity, 84.

Satisfactory as these results are, certain unfavorable conditions must be considered. Very little ground was properly fall-prepared. An unusually late spring delayed the planting for nearly three weeks. In midsummer a dry spell of about six weeks' duration affected the beet crop on account of the late planting.

The cost of production is variously stated as running from \$30 to \$40 per acre. As is always the case with business men's organizations engaged in sugar-beet raising on rented land, the cost of production on our 40-acre experimental field was excessively high and can not serve as a criterion. Our net profit was small, as expected beforehand, but with 12 tons per acre and \$5 per ton net we certainly received a handsome amount of money to distribute among our people for land rent, hand labor, team work, etc.

Owatonna, a beautiful town of 7,000 population, wishes to secure the second plant to be located in Minnesota. We have made no special effort to that effect, but are

determined to continue our work on an increasing scale in order to be able to submit facts and actual results at the proper time. Practically every section in this district is well adapted for beets, farms are medium and small, mostly in the hands of thrifty Germans, Bohemians, and Scandinavians. We have three main steam lines, and an electric line is now in course of construction. A river of sufficient capacity is running through the town. Limestone of excellent quality is quarried at a point 15 miles from here and will probably be found just outside our city limits.

Respectfully,

OWATONNA SUGAR-BEET GROWERS' ASSOCIATION,
HERMAN HARDER, *Secretary*.
C. H. ROSEBROCK, *President*.

MONTANA.

HAMILTON, MONT., *January 7, 1910.*

DEAR SIR: We did not get any good out of our beet experiments the past season. We hired a man to look after them that was recommended as an expert. * * * He spoiled the crop, so we just used it for sheep feed without getting any figures on it in the way of tonnage or sugar content.

We are working with the Western Sugar Company of Denver trying to get them to put in a factory here. They sent two men to look the ground over last fall, but they got here too late. They have agreed to come here in the early spring and make a thorough investigation, and if everything is satisfactory they state they will put in a factory for the season of 1911.

Yours, truly,

P. J. SHANNON.

HARLEM, MONT., *January 7, 1910.*

DEAR SIR: Our factory has not as yet materialized, much as it may be regretted, owing to a few pertinent reasons: First, the Amalgamated Beet Sugar Company of Ogden, Utah, made a contract with the Indians through the Department at Washington, D. C., in the year 1907, in which the Indians of the Fort Belknap Reservation, through their agent, W. R. Logan, agreed to grow 3,000 acres of beets in the year 1908, and continue for ten years, at the price of \$4.50 per ton delivered at the factory, which the sugar company agreed to construct for the crop of 1908; but the agent failed to have the beets forthcoming, and the contract was continued to the year 1909, but still the agent and Indians failed, and now operation of our factory is postponed indefinitely. As to the cause of this we lay to the Indian agent at this point, * * * together with the price, \$4.50 per ton, when all other factories are paying \$5 per ton. Any farmer who would otherwise raise beets simply withdrew, and the Indian Department failing, we have very little prospect now of a factory, though our valley of the Milk River, of which the Indians own one-half, has shown the very rich soil necessary for sugar-beet culture, beets showing in some experimental tests as high as 23 per cent sugar and 83 purity. In fact it is universally conceded that the Milk River Valley in northern Montana is equal to any other in the United States. While we have not grown beets to any great extent, we are growing some each year for feeding purposes, with very good success, in some cases the feeder claiming beets to be as cheap at \$7 to \$8 per ton as any other feed, and the tonnage is excellent.

Respectfully,

GEO. W. VENNUM.

NEW MEXICO.

CHICAGO, *January 17, 1910.*

DEAR SIR: Briefly the tests on New Mexico beets for the past year were as follows:

Name.	Station.	Tests of sugar content.			Purity.	Total beets delivered.
		Highest.	Lowest.	Average.		
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Pounds.</i>
Frank Ballinger.....	Maxwell.....	21.4	17.8	20.1	82.3	11,988
E. D. Fulk.....	do.....	20.0	15.6	18.3	82.0	28,952
E. D. and I. F. Haines.....	do.....	20.1	15.0	16.8	81.4	40,587
Maxwell Beet Growers' Association.....	do.....	20.7	14.5	18.0	82.0	80,082
B. S. Richards.....	do.....	20.3	16.7	17.9	81.8	44,511
E. Richards.....	do.....	15.6	12.6	14.2	80.1	10,012
Sol Stukey.....	do.....	17.5	15.0	16.6	81.0	33,385
The Maxwell Land Grant Co.....	Springer.....	18.4	16.8	16.8	82.8	189,888
J. P. Vanhouten Co.....	Shoemaker.....	18.5	16.4	17.9	83.1	65,550
Las Vegas Sugar Beet Growers' Association.....	Las Vegas.....	18.4	16.3	17.3	82.5	221,950

The beets grown in the Albuquerque and Rio Grande districts were so poorly handled that they were not shipped to the factory, and we do not intend to put forth any further effort to develop the growing of beets in that section. Our tests in the northern part of the State will be continued during the coming year.

Yours, very truly,

R. E. WILSON.

EAST LAS VEGAS, N. MEX., *January 8, 1910.*

DEAR SIR: We made a test on a 20-acre piece of land under the most unfavorable circumstances, and I herewith submit through you to the Agricultural Department the result of our work: The yield was 111 tons, an average of $5\frac{1}{2}$ tons to the acre; the average sugar content, $17\frac{1}{2}$ per cent.

This crop of 20 acres was cultivated on the Old Montezuma farm of the Santa Fe Railroad Company.

Very truly, yours,

GEO. H. WARD.

KANSAS.

KANSAS CITY, KANS., *January 6, 1910.*

DEAR SIR: Sugar beets have never been grown here except as an experiment, owing to the fact that we have not had access to a factory until just recently.

The completion of the Garden City, Gulf and Northern Railroad to Scott City, which occurred within the past week, will now make it possible for those wishing to grow beets in this locality to ship to Garden City.

The soil here has been pronounced ideal for sugar beets by experts, the beets testing very high and the tonnage being good. With the abundant underflow and with the pump system of irrigation, we expect considerable development in the production of sugar beets in the next few years.

Very truly, yours,

J. C. MITCHELL.

THE ST. FRANCIS COMMERCIAL CLUB,

St. Francis, Kans., January 5, 1910.

DEAR SIR: I will say in regard to the inquiries which you make regarding the beet-sugar industry in this territory that you have been misinformed if you have been led to believe that it is in the experimental stage. We have raised sugar beets here for years and with the most flattering success. Our beets were shipped to the

factory at Ames, Nebr., and in consequence of the fact that this factory has been moved to Scottsbluff, Nebr., our beet raisers have been unable to secure contracts for raising beets since.

Our beets made an average of 15 tons per acre, many acres making as high as 30 tons. The per cent of sugar was from 12 to 17 and the purity averaged 89.

We have been making a hard fight to get a sugar factory located here, and I am now in correspondence with a Michigan house, which desires to move to a territory where beets can be raised at a profit and where the best results can be obtained. I do not know yet what will be the result, but we hope to secure this company.

Regarding the cost of production, I will say that beets have been grown here at a cost as low as \$22 an acre and as high as \$30, depending upon the knowledge of the raiser, the culture of the plant, and the difference in the seasons. Our beets were raised by irrigation, and we have an abundance of water for this purpose. Beet raisers have been able to secure \$5 per ton, delivered on the cars at this place.

I will say regarding our possibilities that we have about 44,000 acres of good sugar-beet land in this county. We also have an underflow far superior to the Garden City (Kans.) district in the Arkansas River Valley. We have an average velocity of about 26½ feet daily and an average depth of about 12½ feet. We also have unlimited facilities for reservoirs, as nearly all the canyons opening into the Republican River in this county have a good, strong underflow, and with suitable dams at the mouths of these canyons we could irrigate every foot of the rich and valuable beet land lying on the river bottom.

It is with regret that I notice the energies that have been put forth to promote the beet-sugar industry in localities which are very inferior to our district, while we have bent every energy to secure recognition of our superior facilities, but so far have failed to interest any responsible enterprise.

Very truly, yours,

TRAVIS W. BENJAMIN, *Secretary.*

NEBRASKA.

THE SCOTTSBLUFF SUGAR COMPANY,
Scottsbluff, Nebr., January 13, 1910.

DEAR SIR: In reply to your inquiries would state that about 3,500 acres of sugar beets were grown in the North Platte Valley for the Sterling (Colo.) factory last year. The yield ranged from 10 to 18 tons per acre. We are not in possession of the data as to the sugar content of the crop, as the deliveries were made to the Sterling plant; but understand the sugar content was in the neighborhood of 15 per cent, with 80 per cent purity.

We now have under construction a 1,200-ton plant at Scottsbluff, which will be completed in time to work up the crop of next season. Something over 11,000 acres have already been subscribed for next season's planting.

Very truly, yours,

A. V. OFFICER, *Manager.*

NORTH DAKOTA.

WILLISTON, N. DAK., *January 20, 1910.*

DEAR SIR: Answering your letter of recent date I am herewith inclosing you a table giving most of the information you desire. In addition to this I might state that officials of the Amalgamated Sugar Company of Ogden have looked over the ground and stated the field was a very promising one. With the development of the Williston irrigation project and those at Buford and the lower Yellowstone there is but little doubt that a sugar factory will be erected in Williston within the next few years. The sugar people are willing to put up the plant at any time they are assured of beets,

but it requires some time and no little effort to educate the farmers up to the point of raising several thousand acres of beets.

This is a pumping project, electricity being generated through the use of native coal and then transmitted to various pumping stations at the river and along the main canals. The plant is idle during the months a sugar factory would be in operation, and there would be little difficulty in using the government plant for running the factory.

Very truly, yours,

J. W. JACKSON.

Results of sugar-beet growing at Williston, N. Dak.

Grower.	Average weight.	Sugar in juice.	Solids in juice.	Coefficient of purity.
	Ounces.	Per cent.	Per cent.	
Hanna.....	11	12.30	16.45	74.77
Mueller.....	14	20.12	22.67	88.75
Heinbaugh.....	19	16.60	21.80	76.14
Hinebaugh.....	19	15.30	19.59	79.12
Palmer.....	17½	18.60	21.98	84.63
Experimental farm.....	29	17.30	21.80	79.35
Lester.....	28	18.50	22.12	83.63
Elithorpe.....	20	15.10	21.04	71.79
Substation:				
Vilmorin Elite.....	32	14.70	18.45	79.67
Kleinwanzlebener.....	35	15.20	19.54	77.78
Average of sugar and juice.....		16.37	20.54	79.56

OHIO.

FINDLAY, OHIO, ———.

DEAR SIR: The agent of the factory informs me that the acreage in the county will be nearly double next year. Many farmers were induced to plant more acres than they could cultivate. These do not appear well satisfied with the experiment. There will not be 411 acres planted by these same men next year.

Four hundred and eleven acres of beets were delivered at four stations on the Findlay, Fort Wayne and Western Railroad. No beets were ever grown here previous to this. This 411 acres produced 3,610 tons, the average being very close to 9 tons per acre. The sugar in the beets was 17 per cent, the purity 87. The cost of production was \$5 in addition to the work of the farm laborers. No particular effort has been made as yet to secure a factory. The Fremont factory is near and shipping direct.

Yours, respectfully,

P. A. KEMERER.

TEXAS.

AMARILLO CHAMBER OF COMMERCE,
Amarillo, Tex., January 6, 1910.

DEAR SIR: Our acreage of sugar beets was light. A great many farmers grew beets to a limited extent for feed; but few tests were made this season. Those made showed 16.27 to 17.72 per cent of sugar and 82.12 to 84.55 of purity. The average cost of production was \$6.50 per acre.

Last year we wrote all of the sugar-beet people in the country, with a view to interesting them in putting in a factory at this point; but, on account of the unsettled condition of the tariff at that time, did not receive much encouragement. We intend, however, to continue the work, particularly at home, in the way of getting our farmers more interested. Last season we ordered seed for quite a number and expect to do the same next season. Kindly have the Department send us a nice lot of seed.

Yours, very truly,

G. T. GEBHARDT, *Secretary.*

HEREFORD COMMERCIAL CLUB,

Hereford, Tex., January 14, 1910.

DEAR SIR: There was practically no tonnage of sugar beets produced here in 1910. Only a few farmers raised beets, and all on a small scale; none were shipped out. We sent an exhibit of those raised to the Dallas Fair, however, and took first prize over the entire State on them. They were raised by J. H. Bond, of this place. No tests were made of sugar, purity, etc.

We want a factory, but feel that we must secure more acreage before going after it actively. Will the Government help us out in the matter of seeds, so that I may have help in rousing interest?

Very truly, yours,

SETH B. HOLMAN, *Secretary.*

WISCONSIN.

GREEN BAY, WIS., *January 6, 1910.*

DEAR SIR: I am unable to give you detailed data regarding the beets from this section, as they are manufactured in connection with those raised in other territory covered by the Menominee River Sugar Company, of Menominee, Mich. The past season was quite unfavorable, being exceptionally dry, and therefore does not fairly illustrate what may be done here. I will therefore give you figures covering an average year when in Brown County (within a radius of 10 miles of Green Bay) we raised 946 acres of sugar beets which averaged a little less than 12 tons per acre and contained from 14 to 17 per cent of sugar. As these were all raised by the farmers, it has been difficult to ascertain the cost of production, but so far as they are able to give figures, the cost ranged from \$26 to \$35 per acre. An average of \$30 in my judgment would be about right.

As to the efforts being made and the prospects: Considerable agitation resulted in securing a proposition from reliable parties for the erection of a 600-ton plant on condition that \$100,000 be subscribed locally and that there be guaranteed 4,000 acres of beets. That 4,000-acre matter has proven the downfall of the proposition, at least for the present. That acreage can easily be secured in two or, at farthest, three years and even more than that, but for the first year probably not to exceed 2,500 or 3,000 acres could be had. I have gone somewhat into detail that you might have a fair idea of the outlook here, which, considering location, shipping facilities, soil, and inhabitants, would seem to be an exceptionally good point for a 600-ton plant.

Very truly, yours,

E. A. PLUMB.

RACINE, WIS., *January 4, 1910.*

DEAR SIR: I am agent for the Wisconsin Sugar Company in this section of the State and have been for five years. It is only recently that there have been many sugar beets grown in this part of the country, but the last two years the acreage has increased considerably. There were 1,100 acres of beets grown in this vicinity for the year 1909, and they averaged 14 tons per acre, and in some cases they ran as high as 23 tons per acre. The per cent of sugar obtained from the beets was from 14 to 17. The cost of production per acre follows: 15 pounds of seed at 15 cents per pound, \$2.25; hand labor, \$20; horse cultivating, \$3; hauling beets to cars, \$7; and plowing, \$2, making a total of \$34.25 per acre. This is what it costs me. However, I do not live very far from the railroad, and the hauling would cost more in some cases.

Respectfully, yours,

WM. S. DRUMMOND.

COMPARATIVE TESTS OF SUGAR-BEET VARIETIES.^a

BY J. E. W. TRACY,

Bureau of Plant Industry.

The work reported upon in Circular 37 of the Bureau of Plant Industry was continued during the past year in cooperation with the agricultural experiment station at Fort Collins, Colo.; the experiment station of the Michigan State Agricultural College, East Lansing, Mich.; the New York Agricultural Experiment Station, Geneva, N. Y.; the Eastern Oregon Agricultural Experiment Station, Union, Oreg.; and with private individuals under the supervision of the Department of Agriculture at Holland, Mich., and Fairfield, Wash.

Owing to the weather conditions at Union, Oreg., and changes in the experiment station force at Fort Collins, Colo., the results secured in 1909 were not comparable and therefore have been omitted.

The experiments outlined in the circular were completed with the test of 1909, and as no republication of the data in the circular is made it should be consulted to secure a proper understanding of the subject in connection with the following information.

As a matter of convenience, the tables have been arranged and numbered as in the circular. Owing to the omission of reports on the work for 1909 at Fort Collins, Colo., Union, Oreg., and Logan, Utah, Tables IV, VIII, and IX are omitted. Table XII is also omitted, as the relative standing of each variety prior to 1909 is not altered by this year's experiments and the results of 1909 are given in Tables V, VI, VII, and X.

Similar work has been inaugurated this year, which it is proposed to carry on for several years. These experiments will be conducted at St. Louis, Mich., Holland, Mich., Waverly, Iowa, Garden City, Kans., Garland, Utah, Compton, Cal., Nampa, Idaho, Fairfield, Wash., and possibly at other points.

^a Supplementary report to Circular 37, Bureau of Plant Industry. This circular was issued September 27, 1909, and gives detailed information as to the manner of conducting the experiments. It may be secured free upon application to the Secretary of Agriculture or to a Senator or Representative in Congress.

TABLE I.—*Relative performance of sugar-beet varieties for the entire six-year period covered by the tests.*

Designation of variety tested.	Arranged by stations.				Arranged by years.			
	Roots.		Sugar.		Roots.		Sugar.	
	<i>Tons per acre.</i>	<i>Per cent.</i>	<i>Pounds per acre.</i>	<i>Standing of variety tested.</i>	<i>Tons per acre.</i>	<i>Per cent.</i>	<i>Pounds per acre.</i>	<i>Standing of variety tested.</i>
Morrison.....	15.26	16.69	5,011	1	13.40	16.53	4,325	1
Original.....	14.14	17.43	4,847	2	12.49	17.14	4,206	2
Breustedt.....	14.20	16.64	4,664	4	12.69	16.36	4,078	3
Mette.....	14.38	16.48	4,675	3	12.56	16.31	4,007	6
Schreiber.....	13.95	16.95	4,632	5	12.17	17.03	4,041	4
Braune.....	14.40	16.34	4,635	6	12.74	16.15	4,031	5
Heine.....	13.87	16.89	4,608	7	11.98	16.70	3,894	9
Utah.....	13.88	16.78	4,597	8	12.09	16.70	3,962	7
Hoerning.....	14.37	16.25	4,547	9	12.51	16.15	3,911	8
Jaensch.....	13.79	16.55	4,506	10	11.93	16.44	3,839	11
Dippe.....	13.43	16.85	4,452	11	11.86	16.67	3,864	10
Kuhn.....	12.88	17.12	4,333	12	11.54	16.87	3,821	12

TABLE II.—*Standing of sugar-beet varieties tested at each and all stations.*

Designation of variety tested.	Michigan, East Lansing (tested five years).				Michigan, Holland (tested six years).			
	Roots.		Sugar.		Roots.		Sugar.	
	<i>Tons per acre.</i>	<i>Per cent.</i>	<i>Pounds per acre.</i>	<i>Standing at station.</i>	<i>Tons per acre.</i>	<i>Per cent.</i>	<i>Pounds per acre.</i>	<i>Standing at station.</i>
Morrison.....	12.12	17.32	4,123	4	8.23	14.43	2,367	3
Original.....	11.92	18.47	4,267	2	7.80	14.78	2,306	5
Breustedt.....	11.97	17.21	4,066	5	8.16	13.98	2,243	7
Mette.....	11.06	17.14	3,752	11	8.07	13.67	2,191	10
Schreiber.....	12.81	18.08	4,560	1	7.87	14.80	2,327	4
Braune.....	11.92	17.08	3,973	6	7.81	14.30	2,216	9
Heine.....	11.92	17.67	4,151	3	7.55	14.43	2,168	11
Utah.....	10.95	17.72	3,819	9	6.59	14.26	1,852	12
Hoerning.....	10.19	17.42	3,444	12	8.89	14.33	2,542	1
Jaensch.....	11.33	17.60	3,816	10	8.31	14.32	2,375	2
Dippe.....	11.38	17.22	3,839	8	7.45	14.85	2,225	8
Kuhn.....	10.92	17.71	3,858	7	7.69	14.62	2,260	6

Designation of variety tested.	New York, Geneva (tested six years).				Washington, Fairfield (tested six years).			
	Roots.		Sugar.		Roots.		Sugar.	
	<i>Tons per acre.</i>	<i>Per cent.</i>	<i>Pounds per acre.</i>	<i>Standing at station.</i>	<i>Tons per acre.</i>	<i>Per cent.</i>	<i>Pounds per acre.</i>	<i>Standing at station.</i>
Morrison.....	17.11	14.55	5,054	1	6.09	20.87	2,551	1
Original.....	14.76	14.91	4,441	3	5.95	20.99	2,522	2
Breustedt.....	15.48	14.33	4,478	2	5.91	20.10	2,374	8
Mette.....	14.12	14.51	4,104	9	5.86	20.36	2,383	5
Schreiber.....	14.61	14.96	4,375	4	5.79	21.16	2,464	3
Braune.....	15.11	14.41	4,357	5	5.44	19.77	2,164	12
Heine.....	13.98	14.62	4,065	10	5.28	20.88	2,223	11
Utah.....	14.31	15.07	4,305	7	5.92	20.13	2,386	4
Hoerning.....	13.83	14.10	3,900	12	5.87	20.33	2,379	6
Jaensch.....	14.51	14.37	4,178	8	5.91	20.10	2,378	7
Dippe.....	14.52	14.84	4,352	6	5.68	20.65	2,366	9
Kuhn.....	13.97	14.38	4,050	11	5.65	20.74	2,365	10

TABLE II.—*Standing of sugar-beet varieties tested at each and all stations—Continued.*

Designation of variety tested.	Average of all tests.			
	Roots.	Sugar.		Relative standing.
		<i>Tons per acre.</i>	<i>Per cent.</i>	
Morrison.....	15.26	16.69	5,011	1
Original.....	14.14	17.43	4,847	2
Breustedt.....	14.20	16.64	4,664	4
Mette.....	14.38	16.48	4,675	3
Schreiber.....	13.95	16.95	4,632	6
Braune.....	14.40	16.34	4,635	5
Heine.....	13.87	16.89	4,608	7
Utah.....	13.88	16.78	4,597	8
Hoerning.....	14.37	16.25	4,547	9
Jaensch.....	13.79	16.55	4,506	10
Dippe.....	13.43	16.85	4,452	11
Kuhn.....	12.88	17.12	4,333	12

TABLE III.—*Standing of sugar-beet varieties tested at all stations for 1909 and for all years.*

Designation of variety tested.	1909.				Average for all years.			
	Roots.	Sugar.		Stand- ing for year.	Roots.	Sugar.		Relative stand- ing.
		<i>Tons per acre.</i>	<i>Per cent.</i>			<i>Tons per acre.</i>	<i>Per cent.</i>	
Morrison.....	9.13	17.48	2,999	6	13.40	16.53	4,325	1
Original.....	9.22	17.83	3,087	3	12.49	17.14	4,206	2
Breustedt.....	8.84	17.32	2,894	8	12.69	16.36	4,078	3
Mette.....	8.86	18.01	3,029	5	12.56	16.31	4,007	6
Schreiber.....	9.06	18.33	3,175	2	12.17	17.03	4,041	4
Braune.....	9.00	17.39	2,972	7	12.74	16.15	4,031	5
Heine.....	8.96	17.26	2,859	9	11.98	16.70	3,894	9
Utah.....	8.95	17.72	3,037	4	12.09	16.70	3,962	7
Hoerning.....	8.29	17.97	2,823	12	12.51	16.15	3,911	8
Jaensch.....	9.49	18.01	3,230	1	11.93	16.44	3,839	11
Dippe.....	8.54	17.22	2,840	10	11.86	16.67	3,864	10
Kuhn.....	8.45	17.90	2,836	11	11.54	16.87	3,821	12
Aderstedt.....	8.61	17.40	2,812	.....	.....	.....	.....	.....
Idaho.....	8.22	17.34	2,708	.....	.....	.....	.....	.....
Behren.....	9.54	17.66	3,222	.....	.....	.....	.....	.....
Old Type.....	9.24	18.36	3,154	.....	.....	.....	.....	.....
Zuckerreichet.....	9.01	16.92	2,884	.....	.....	.....	.....	.....
Pioneer.....	8.91	18.45	3,151	.....	.....	.....	.....	.....
Strandes.....	8.40	16.96	2,634	.....	.....	.....	.....	.....
Wohanka.....	9.39	17.33	3,064	.....	.....	.....	.....	.....

TABLE V.—*Standing of sugar-beet varieties tested at the Agricultural Experiment Station, East Lansing, Mich., for 1909 and average for five years.*

Designation of variety tested.	1909.				Average for five years.					
	Roots.		Sugar.		Stand- ing for year.	Roots.		Sugar.		Rela- tive stand- ing.
	<i>Tons per acre.</i>	<i>Per cent.</i>	<i>Pounds per acre.</i>			<i>Tons per acre.</i>	<i>Per cent.</i>	<i>Pounds per acre.</i>		
Morrison.....	12.00	18.50	4,440	3	12.12	17.32	4,123		4	
Original.....	10.84	19.80	4,293	6	11.92	18.47	4,267		2	
Breustedt.....	10.92	17.60	3,844	17	11.97	17.21	4,066		5	
Mette.....	10.92	19.70	4,302	5	11.06	17.14	3,752		11	
Schreiber.....	11.01	18.50	4,074	13	12.81	18.08	4,560		1	
Braune.....	11.26	18.90	4,256	9	11.92	17.08	3,973		6	
Heine.....	10.90	18.30	3,989	15	11.92	17.67	4,151		3	
Utah.....	10.75	19.30	4,150	11	10.95	17.72	3,819		9	
Hoerning.....	10.62	18.40	3,908	16	10.19	17.42	3,444		12	
Jaensch.....	11.26	18.70	4,211	10	11.33	17.60	3,816		10	
Dippe.....	11.22	18.40	4,129	12	11.38	17.22	3,839		8	
Kuhn.....	11.13	19.20	4,274	7	10.92	17.71	3,858		7	
Aderstedt.....	10.67	20.00	4,268	8						
Idaho.....	10.78	16.70	3,601	19						
Behren.....	13.22	17.10	4,521	1						
Old Type.....	11.18	19.30	4,315	4						
Zuckerreicht.....	11.99	18.60	4,460	2						
Pioneer.....	10.98	18.40	4,041	14						
Strandes.....	9.92	16.50	3,274	20						
Wohanka.....	10.54	17.90	3,773	18						

TABLE VI.—*Standing of sugar-beet varieties tested at the Holland, Mich., station (Will Kremers in charge) for 1909 and average for six years.*

Designation of variety tested.	1909.				Average for six years.					
	Roots.		Sugar.		Stand- ing for year.	Roots.		Sugar.		Rela- tive stand- ing.
	<i>Tons per acre.</i>	<i>Per cent.</i>	<i>Pounds per acre.</i>			<i>Tons per acre.</i>	<i>Per cent.</i>	<i>Pounds per acre.</i>		
Morrison.....	5.46	14.80	1,616	10	8.23	14.43	2,367		3	
Original.....	7.19	13.80	1,984	5	7.80	14.78	2,306		5	
Breustedt.....	5.47	13.60	1,488	14	8.16	13.98	2,243		7	
Mette.....	6.16	13.90	1,712	6	8.07	13.67	2,191		10	
Schreiber.....	6.70	14.90	1,997	3	7.87	14.80	2,327		4	
Braune.....	4.71	13.40	1,262	18	7.81	14.30	2,216		9	
Heine.....	4.98	14.60	1,454	15	7.55	14.43	2,168		11	
Utah.....	5.62	13.70	1,540	12	6.59	14.26	1,852		12	
Hoerning.....	5.52	14.20	1,568	11	8.89	14.33	2,542		1	
Jaensch.....	7.18	14.40	2,068	1	8.31	14.32	2,375		2	
Dippe.....	5.80	14.00	1,624	9	7.45	14.85	2,225		8	
Kuhn.....	5.10	14.80	1,510	13	7.69	14.62	2,260		6	
Aderstedt.....	4.53	12.50	1,133	20						
Idaho.....	4.00	14.70	1,176	19						
Behren.....	4.89	13.70	1,340	17						
Old Type.....	5.50	15.00	1,650	7						
Zuckerreichet.....	5.16	13.40	1,383	16						
Pioneer.....	6.96	14.80	2,060	2						
Strandes.....	5.69	14.50	1,650	7						
Wohanka.....	7.94	12.50	1,985	4						

TABLE VII.—*Standing of sugar-beet varieties tested at the New York Agricultural Experiment Station, Geneva, N. Y., for 1909 and average for six years.*

Designation of variety tested.	1909.				Average for six years.				
	Roots.	Sugar.		Standing for year.	Roots.	Sugar.		Relative standing.	
		<i>Tons per acre.</i>	<i>Per cent.</i>			<i>Tons per acre.</i>	<i>Per cent.</i>		
Morrison.....	12.83	10.50	2,694	17	17.11	14.55	5,054	1	
Original.....	12.75	11.10	2,831	14	14.76	14.91	4,441	3	
Breustedt.....	13.13	12.40	3,256	6	15.48	14.33	4,478	2	
Mette.....	12.68	12.40	3,145	10	14.12	14.51	4,104	9	
Schreiber.....	12.35	13.70	3,384	3	14.61	14.96	4,375	4	
Braune.....	13.88	11.60	3,220	7	15.11	14.41	4,357	5	
Heine.....	13.88	10.20	2,832	13	13.98	14.62	4,065	10	
Utah.....	13.35	12.70	3,391	2	14.31	15.07	4,305	7	
Hoerning.....	11.40	12.20	2,782	16	13.83	14.10	3,900	12	
Jaensch.....	13.28	12.70	3,373	4	14.51	14.37	4,178	8	
Dippe.....	10.99	11.50	2,528	20	14.52	14.84	4,352	6	
Kuhn.....	11.93	10.60	2,529	19	13.97	14.38	4,050	11	
Aderstedt.....	13.65	10.50	2,867	12	.....	.....	.....	.....
Idaho.....	12.00	12.10	2,904	11	.....	.....	.....	.....
Behren.....	13.95	13.80	3,850	1	.....	.....	.....	.....
Old Type.....	14.18	11.60	3,290	5	.....	.....	.....	.....
Zuckerreicht.....	13.13	10.70	2,810	15	.....	.....	.....	.....
Pioneer.....	11.60	13.80	3,174	9	.....	.....	.....	.....
Strandes.....	12.30	10.80	2,657	18	.....	.....	.....	.....
Wohanka.....	12.83	12.50	3,208	8	.....	.....	.....	.....

TABLE X.—*Standing of sugar-beet varieties tested at Fairfield, Wash. (Joseph F. Reed in charge), for 1909 and average for six years.*

Designation of variety tested.	1909.				Average for six years.				
	Roots.	Sugar.		Standing for year.	Roots.	Sugar.		Relative standing.	
		<i>Tons per acre.</i>	<i>Per cent.</i>			<i>Tons per acre.</i>	<i>Per cent.</i>		
Morrison.....	6.21	26.13	3,245	6	6.09	20.87	2,551	1	
Original.....	6.09	26.60	3,240	7	5.95	20.99	2,522	2	
Breustedt.....	5.82	25.65	2,986	16	5.91	20.10	2,374	8	
Mette.....	5.68	26.03	2,957	18	5.86	20.36	2,383	5	
Schreiber.....	6.19	26.22	3,246	5	5.79	21.16	2,464	3	
Braune.....	6.14	25.65	3,150	11	5.44	19.77	2,164	12	
Heine.....	6.09	25.95	3,161	9	5.28	20.88	2,223	11	
Utah.....	6.09	25.18	3,067	13	5.92	20.13	2,386	4	
Hoerning.....	5.60	27.08	3,033	14	5.87	20.33	2,379	6	
Jaensch.....	6.23	26.22	3,267	4	5.91	20.10	2,378	7	
Dippe.....	6.16	24.99	3,079	12	5.68	20.65	2,366	9	
Kuhn.....	5.62	26.98	3,032	15	5.65	20.74	2,365	10	
Aderstedt.....	5.60	26.60	2,979	17	.....	.....	.....	.....
Idaho.....	6.10	25.84	3,152	10	.....	.....	.....	.....
Behren.....	6.10	26.03	3,176	8	.....	.....	.....	.....
Old Type.....	6.10	27.55	3,361	1	.....	.....	.....	.....
Zuckerreicht.....	5.77	24.99	2,884	20	.....	.....	.....	.....
Pioneer.....	6.21	26.79	3,327	2	.....	.....	.....	.....
Strandes.....	5.68	26.02	2,956	19	.....	.....	.....	.....
Wohanka.....	6.23	26.41	3,291	3	.....	.....	.....	.....

TABLE XI.—*Relative standing, by stations and by years, of sugar-beet varieties tested for all years.*

Designation of variety tested.	Arranged by stations.							
	Colorado (Fort Collins), 3 years.	Michigan (East Lansing), 5 years.	Michigan (Holland), 6 years.	New York (Geneva), 6 years.	Oregon (Union), 3 years.	Utah (Logan), 4 years.	Washington (Fairfield), 6 years.	All stations.
Morrison.....	1	4	3	1	1	2	1	1
Original.....	5	2	5	3	2	1	2	2
Breustedt.....	9	5	7	2	9	3	8	4
Mette.....	2	11	10	9	^a 5	7	5	3
Schreiber.....	8	4	4	4	10	12	3	6
Braune.....	6	6	9	5	4	5	12	5
Heine.....	7	3	11	10	8	4	11	7
Utah.....	4	9	12	7	^a 5	6	4	8
Hoerning.....	3	12	1	12	11	9	6	9
Jaensch.....	10	10	2	8	3	10	7	10
Dippe.....	11	8	8	6	7	11	9	11
Kuhn.....	12	7	6	11	12	8	10	12

Designation of variety tested.	Arranged by years.						
	1904.	1905.	1906.	1907.	1908.	1909.	All years.
Morrison.....	1	7	1	1	2	6	1
Original.....	3	3	2	4	1	3	2
Breustedt.....	9	2	5	2	6	8	3
Mette.....	10	12	4	6	4	5	6
Schreiber.....	2	6	6	12	3	2	4
Braune.....	4	4	9	3	7	7	5
Heine.....	6	5	7	11	9	9	9
Utah.....	7	9	10	5	8	4	7
Hoerning.....	11	10	3	7	10	12	8
Jaensch.....	12	13	8	8	11	1	11
Dippe.....	5	1	11	10	12	10	10
Kuhn.....	8	11	12	9	5	11	12

^a The Mette and the Utah varieties have the same relative standing at Union, Oreg.

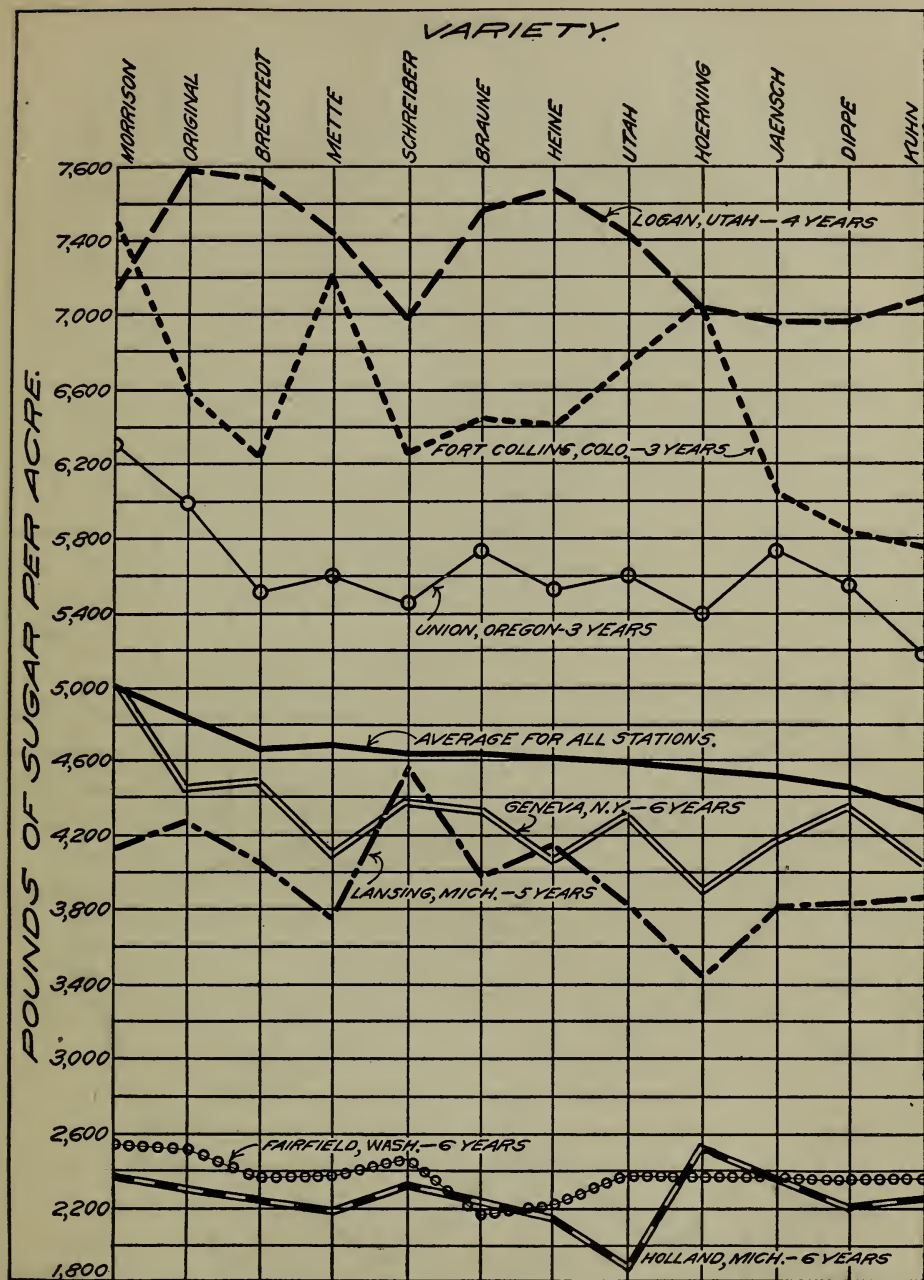


FIG. 1.—Diagram showing the standing of sugar-beet varieties tested at each station and at all stations.

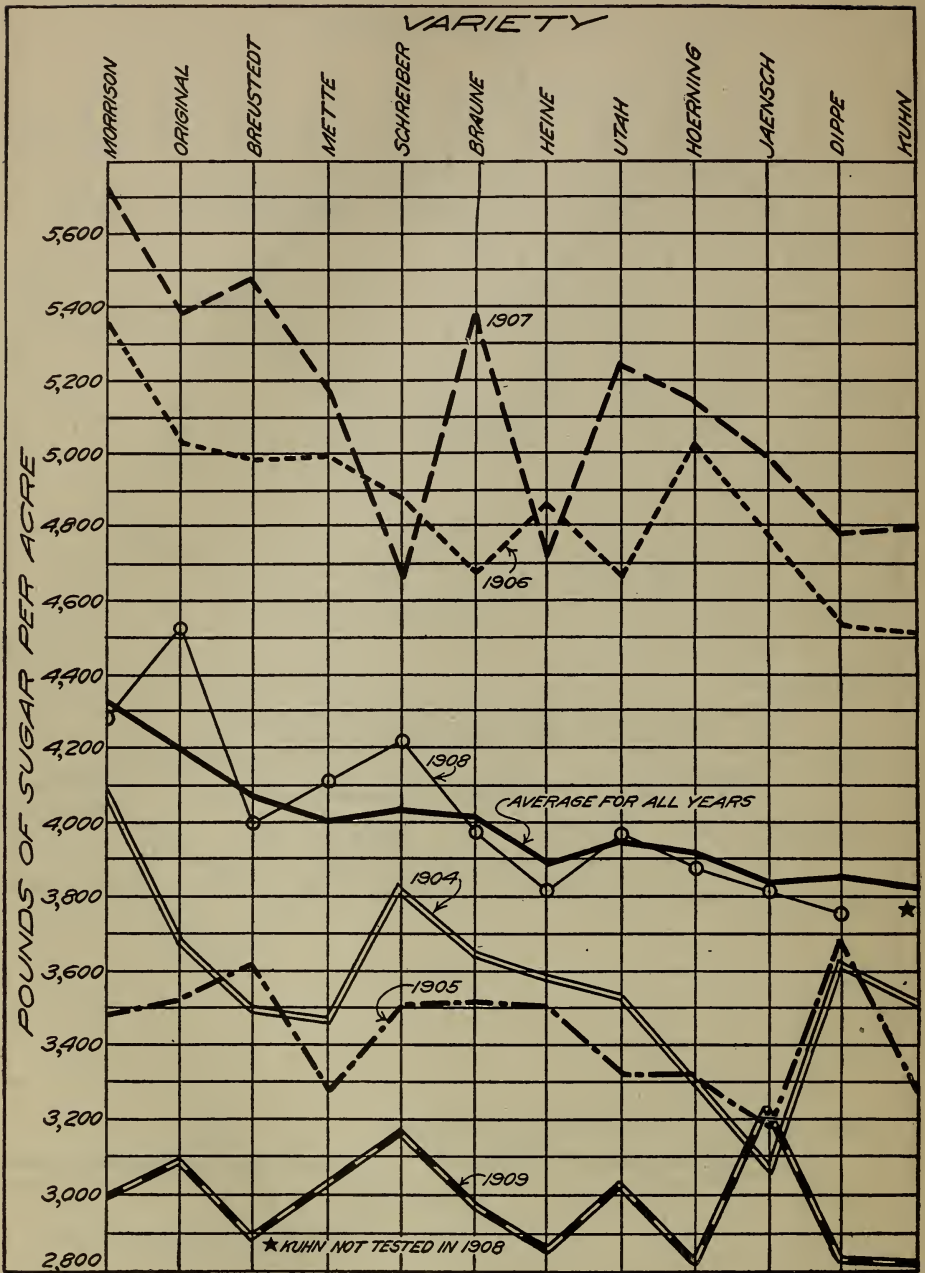


FIG. 2.—Diagram showing the standing of sugar-beet varieties tested for each year and for all years.

THE CURLY-TOP OF BEETS.^a

BY HARRY B. SHAW,

Bureau of Plant Industry.

The sporadic outbreaks during the past ten years of the disease of beets known generally as curly-top, or more locally referred to as blight, western blight, or whiskered beets, have caused a great loss to the sugar-beet growers in our Western States. In some localities practically the entire sugar-beet crop has been destroyed, and apparently no kind of beet is immune from attack. Even when affected beets, attacked comparatively late in the season, do produce roots of fair size, they possess a high percentage of impurities, and are on that account not so desirable to the sugar companies as are healthy beets.

SYMPTOMS.

The external symptoms of curly-top are numerous and may be found in all parts of affected plants. Commonly the earliest to appear is an inward curling of the inner leaves from the entire margin toward the midrib. Almost simultaneously a distortion of the veins of the affected leaves may be noted; these become wrinkled and knotted on the dorsal surface of the leaf. As the disease progresses more leaves, and finally the whole plant, becomes involved; nipple-like protuberances develop on the veins, sometimes to the length of about three-sixteenths of an inch, and the whole leaf becomes tightly curled from either side. The petioles remain much shorter than in the normal plant and become bowed, with the concavity inward; the crown is generally quite perceptibly wider than in the healthy beet, owing largely to an abnormal growth of small and imperfectly formed leaves outside of and around the original set of leaves; and the leaves and petioles bunch closely together instead of opening out and spreading.

The foliage is generally of a dark, dull green color and quite brittle, though thick and leathery in appearance. In severe cases, especially among young plants, the outer leaves soon become yellow, die, and turn brown; the inner whorls follow until the entire plant is killed.

The roots throw out dense masses of rootlets from the two spiral grooves; hence the names "hairy-root" and "whiskered beets."

^a This article is an abstract of Bulletin 181, Bureau of Plant Industry, U. S. Department of Agriculture, "The Curly-Top of Beets," by Harry B. Shaw.

The root itself looks tough and fibrous and in many cases becomes sprangling. When pulled up masses of soil cling to the hair-like rootlets and are with difficulty shaken off. The growth of every portion of the plant is checked, if not entirely arrested. This is the type most commonly noted on sugar beets.

In many cases the leaf-curl assumes an alternative form. Instead of an inward curl, the leaf as a whole becomes strongly retracted and each portion between the larger veins is puffed out. This results in a blistered or "savoyed" effect. The petioles are short and bowed. In this type the vein symptoms are not usually so pronounced. Sometimes the two types are combined; the leaf as a whole is then retracted, but the margin curls inward. Frequently wine-colored stains develop in the form of small circular spots over the surface of leaves of mangel-wurzel and garden beets, but no local discoloration has been noted on sugar beets, except a faint mottling of young leaves, which can be seen only by transmitted light.

Certain distortions of the cells of the tissues of leaf and stem have been observed in beets affected with curly-top; the fibrovascular bundles may become darkened throughout the entire length of the root. No decay or softening of the tissues has been noted as a direct consequence of the disease; on the contrary, the root becomes tougher and more fibrous, thus rendering the slicing of the beets more difficult, with frequent clogging of the cutters. In many roots a blackened area, or even a cavity with black walls, may be found in the interior of the crown. Very young beets may be so severely attacked that they are killed before the symptoms have time to develop.

SYMPTOMS IN SEED BEETS.

The symptoms of curly-top in beets grown a second season for the production of seed are generally more diverse than in beets during their first season. Apparently this is due to the greater resistance of the seed beets on account of their size. Among seed beets affected a much larger proportion of the retracted type prevails. The types of symptoms noted in the development of the disease in beets during their second season are as follows:

(1) and (2) The types already described, together with pronounced inhibition of growth and the early appearance of a feeble seed stem, which sometimes does and sometimes does not mature seed. The retracted form is perhaps the most abundant one among seed beets and is found also on sugar beets that succumb late in the season after attaining a considerable size.

(3) The type with long, narrow, sinuous, thick, leathery-looking leaves; without marginal curl or vein symptoms; no seed stems;

almost entire inhibition of growth after first month or six weeks; dull, dark-green foliage, inclined to russet.

(4) The type with small rosettes of leaves similar to those of the second type mentioned, but much smaller; very early cessation of growth; no seed stems; very feeble vitality, yet root quite solid and crisp.

(5) The type with root apparently as sound and crisp when planted as the most healthy beet, yet making no growth at all.

(6) The type with part of shoots affected with marginal curl, inward; growth not otherwise seriously affected; part of shoots apparently normal.

(7) The type with no visible symptoms of the disease, but general growth checked.

(8) Combinations of any of the foregoing.

Quite frequently the roots of seed beets affected with curly-top are found to have rotted areas of varying extent, sometimes involving the greater part of the root. This is not to be attributed to curly-top, but is probably brought about by the entrance of various organisms, such as *Phoma betae*, *Rhizoctonia*, etc.

The additional symptoms described for seed beets may be seen also in sugar beets when quite large plants are attacked by so many leaf hoppers that they finally contract the disease.

ONLY ONE SYMPTOM REALLY CHARACTERISTIC.

It is to be noted that most of the symptoms of curly-top, taken individually, may appear under other pathological or physiological conditions; so far as observed, the one real exception is the vein symptom. However, the totality of the symptoms described in this connection has not been observed apart from curly-top.

CAUSES OF THE DISEASE.

The probable connection of the beet leafhopper (*Eutettix tenella* Baker) with curly-top had been suggested by Dr. E. D. Ball, now director of the Utah Agricultural Experiment Station and then special agent of the Bureau of Entomology. He based his opinion upon field observations. In 1908 Mr. H. B. Shaw, of the Bureau of Plant Industry, definitely proved that curly-top was due to the punctures of the leafhopper, by a series of carefully conducted experiments in which the insects were introduced into cloth cages covering sugar beets, from which all other insects were excluded. The beets which had been punctured by the leafhoppers under these conditions became affected with curly-top in ten to eighteen days, while others exposed only to aphides, red spiders, and thrips remained free from

curly-top. Again, live beet leafhoppers were sent by mail to Washington and placed on beets in the greenhouse there, which began to be affected after about twenty-six days, the uninoculated beets remaining healthy. Similar experiments repeated under a variety of conditions gave corroborative results, which are outlined in detail in Bulletin 181 of the Bureau of Plant Industry.

DESCRIPTION OF THE BEET LEAFHOPPER.

It is highly desirable that beet growers should be able to recognize the beet leafhopper, so that its earliest appearance may be noted. If successful preventive measures shall be devised, it is essential that prompt information be had of the first appearance of leafhoppers in considerable numbers, so that such devices may be put in operation at once. Experiments tend to prove that no other species of leafhopper is able to induce curly-top.

The beet leafhopper (*Eutettix tenella*) is very generally, though erroneously, known in the Western States as the "white fly." The white fly, properly so called (*Aleyrodes citri* R. and H.), is a quite different insect and a common pest of citrus trees. The name "white fly" is doubtless somewhat descriptive of the general appearance of the insect, which is of a light yellowish-green tint, looking white at a little distance. In size it is almost one-eighth of an inch long and about one-thirtieth of an inch wide. The nymphs vary in size from but little larger than the egg to almost adult size, according to age; their range of color is almost as great as that of size. More commonly they are of a creamy white, with irregular areas of brown about the abdomen. These brown areas vary greatly in the amount of pigmentation, so that in general appearance the color ranges through pale cream, buff, light reddish brown, and deeper and deeper browns until some seem almost black; a few have distinctly red markings. The nymphs produce the symptoms of curly-top much more rapidly than do the adult insects.

Several other species of leafhopper commonly found on beets closely resemble *Eutettix tenella* in size and color, and few but trained entomologists can readily distinguish between them.

The beet leafhopper is single brooded and begins to deposit its tiny white eggs in the stems and midribs of beet leaves from about the end of June—the time doubtless varying somewhat with the locality and local climatic conditions—until the end of August. Probably the majority of the eggs are deposited by the middle of July. The nymphs begin to appear about the second week in July, and their appearance has been observed in considerable numbers in Idaho as late as the end of August. Slit-like scars are produced on the beet stems where the eggs have been deposited; sometimes these ovipository scars are very numerous and conspicuous. The egg stage appears

to last about fifteen days, and the young insects reach the adult stage in about twenty days more. These adults hibernate and resume their activity the following spring. In Utah and Idaho they have been seen on weeds in May and on beets near the end of May or early in June. The greater portion of the nymph stage appears to be spent among the inner leaves and petioles of the plant, where the egg is hatched, and as the insect approaches the adult stage it gradually works outward.

The beet leafhopper is an exceedingly active insect; its ordinary mode of locomotion is by hops of lightning-like rapidity. The range of its leap seems to be about 18 inches. The adult while on beets uses its wings but little. It is provided with powerful head parts and a stout bill, which, when not in use, is tucked snugly against the under side of the body.

HABITAT AND HOST PLANTS.

The natural habitat of the leafhopper seems to be confined to the mountainous portions of the southwestern part of the United States, as far north as Oregon and southern Idaho and west to the Pacific coast—the sagebrush country—and no outbreaks of curly-top are known to have occurred outside this range. While there is some doubt as to its original host plants, probably the principal ones are greasewood (*Sarcobatus* sp.), sea-blite (*Dondea* sp.), *Atriplex* sp., and Russian thistle.

HOW LEAFHOPPERS INDUCE CURLY-TOP.

In common with several closely related species, this leafhopper is a true sucking insect. However, it is evident that the profound disturbances induced in beets by the leafhoppers are not due to the extraction of plant juices. Some active agent obviously must be left in the plant tissues which is capable of inducing these disturbances. A plant like the beet is able to withstand the loss of much more juice than could be extracted by the few leafhoppers that are necessary to induce a bad case of curly-top. The work of but one leafhopper for a few minutes on a young beet has been shown to be capable of producing the curly-top symptoms, while hundreds of such insects as aphides and red spiders on beet leaves produce only a local leaf-curl and a discoloration of the parts attacked. Even when the entire plant is covered with such insects the new growth is normal.

The symptoms of curly-top have been observed only in growing tissues. Apparently all division is strongly inhibited. This inhibition seems to operate unequally; for, though the growth of the leaf as a whole is checked, the vascular bundles seem to be held back more than the parenchyma between them; the vascular bundles soon swell out

between the large veins and produce the "savoyed" effect so frequently noted. To the naked eye no puncture is visible, nor is any local discoloration due to the punctures to be seen by reflected light, as may be seen in the case of other species of hopper, for example, *Eutettix strobilatus* Fitch, which shows a crimson-lake spot at the site of every puncture. However, a faint mottling of green, with lighter green in the parenchyma of leaves of young beets, has on careful inspection been discerned by transmitted light when the curly-top symptoms were developing.

In some badly infested beet fields leafhoppers have been seen feeding on the dock (*Rumex crispus* L.), and the leaves, especially the inner ones, of these docks were thickly besprinkled with small, wine-colored, circular spots. These spots coalesced when very numerous in a small area, and where they appeared on the petioles and veins the discoloration ran some distance along the fibro-vascular bundles. As these leaves get older they become suffused with red in the more spotted areas. The same phenomenon has also been noted on infested mangel-wurzels or stock beets.

It appears that young beets or those in any way retarded or rendered weak are more likely to succumb to attacks of leafhoppers than beets which are well established. Vigorous beets of four months' growth or older will offer considerable resistance, but however large and vigorous the beets may be they can not resist the persistent attacks of the insects in large numbers. Furthermore, it may be said that beets once affected with curly-top never recover; even when the affected foliage is cut back repeatedly at intervals of several weeks the new growth exhibits unabated symptoms. It has not been found possible to communicate the disease from affected to healthy beets.

CURLY-TOP IN SEED BEETS.

Seed beets are nearly always able to resist the attacks of the leafhoppers successfully. If seed beets are really healthy when planted—that is, if they have not been attacked by curly-top during their first season's growth—they are too vigorous to succumb completely during their season as seed beets. By the time leafhoppers have time to appear in numbers the leaves of the seed beets are usually fully grown. Individual shoots and racemes put forth late in the season may manifest the symptoms if attacked by the hoppers, but the plant as a whole has not been known to become involved. Then, too, the entire aftergrowth, which generally develops late in the summer, may exhibit pronounced signs of disease, but this does not affect the seed, which by this time is usually already gathered. An attack involving the whole seed beet, however, is probably without exception the result of attacks during the preceding season.

It is not safe to use as seed beets plants taken from a field infested with the hoppers, even though the plants selected have manifested no signs of having been attacked. The results attained by the experiments show that the changes set up by beet leafhoppers are profound and persistent and that while a beet subjected to the attack of the insect during the first season may have resisted to the extent of growing to about normal size without exhibiting signs of the disease, some reaction may have been initiated that will show itself in the manner characteristic of curly-top the following spring if the beets be planted for the production of seed. Not only will it be unprofitable to silo sugar beets harvested from an area badly affected with curly-top, but even if only a sprinkling of plants show visible signs of the disease in a field where the leafhoppers are numerous, a more or less considerable percentage of loss may be expected through the development of the disease in seed beets the following season. The probable amount of loss will obviously depend on the number of leafhoppers present during the preceding season, together with the general vigor of the plants at that time and the length of time the leafhoppers had been at work on the beets.

AFFECTED SEED BEETS ALMOST NONPRODUCTIVE.

The serious nature of curly-top is heightened by the fact that few seed beets affected by it produce seed. Of those possessing sufficient vitality to produce seed stems, many dry up and die before maturity; the very few that produce seed are so puny and stunted as to produce but a small fraction of a normal yield. When put in plain figures this loss is very striking. In an experimental test, plants subjected to the attack of leafhoppers during their first season, but showing no curly-top when siloed, produced an average of only 13.82 grams of seed; those exhibiting signs of the disease when harvested produced an average of but 12.25 grams per plant. The average for the healthy beets was about 275 grams, or about twenty-eight times as much as the yield of affected plants.

SEVERE OUTBREAKS NOT FREQUENT IN A LOCALITY.

A notable feature of curly-top is that, so far as has been recorded, there never has been a serious outbreak two seasons in succession in any locality. Therefore, the farmer may be encouraged to continue the culture of sugar beets in spite of the heavy loss consequent on a single attack.

PROGENY OF THE DISEASED SEED BEETS HEALTHY.

Another striking feature of curly-top is that the seed from an affected seed beet will produce healthy sugar beets, which in turn afford vigorous and healthy seed beets unless in the mean time they are attacked by more leafhoppers. Hence the seed from affected beets need not be discarded on account of the disease.

REMEDIES SUGGESTED.

No specific remedy can yet be recommended for the suppression of curly-top. Of course, the perfect remedy is to be found in the destruction of the leafhopper. Already experiments with sprays have been carried on, in cooperation with the Bureau of Entomology, in the hope of devising a method of holding the leafhopper in check. It has been found that, if it can be thoroughly applied to the insects, a strong kerosene and whaleoil-soap emulsion will kill them. However, the time is so short when the spray might be efficaciously applied that it is not yet certain that spraying will be practicable. Furthermore, it is not easy to apply a spray to the beet leafhopper, because of the protection afforded by its wings.

Certain natural and artificial barriers may prevent or check the invasion of the pests. For example, the intervention of a considerable area of land occupied by crops not known to act as food plants to the beet leafhopper probably acts as a more or less effective barrier, while the land immediately contiguous to a wide stretch of sagebrush country is likely to be invaded in any season when the hoppers are abundant. It is thought that the intervention of a mountain or a large body of water will be effective and that the direction of the prevailing winds has an influence.

In conclusion it might be said that anything that retards an early and rapid growth of the beets or encourages the activity and multiplication of the insects is favorable to severe outbreaks of curly-top. There is little doubt that weather has an important bearing on the matter, on account of its influence on the growth and consequent resisting power of the beets; also quite possibly on account of its influence on the leafhopper. It appears that dry, hot seasons favor curly-top and that a cold, dry, backward spring, when the seed is slow to germinate and makes still more tardy growth after germination, is particularly favorable to an outbreak of the disease. Though leafhoppers are able to work and induce the disease under conditions extremely varied, both as regards temperature and actual and relative humidity, hot, dry weather stimulates their activity and hence helps to render the development of the disease more rapid and severe. Everything considered, there is good reason to urge the early sowing of beets, in order to get the

plants well established before the leafhoppers become numerous. It is considered advisable to plant as early as practicable after danger of late frost is over, and even to take some risks of late frost.

The following recommendations, found in Bulletin 66, Part IV, of the Bureau of Entomology, pages 47-48, are quoted:

More should be known about the places of hibernation and early spring history of this insect. It could not be found in the rubbish around the fields in early spring, and only a few specimens were found in waste places up to the time they appeared on the beets. When once the place where the greater number of them pass the winter is discovered it may be possible to destroy them there or on their spring food plants before they migrate to the beets. After they have appeared on the beets it will be necessary to be very prompt in the matter of remedies if the injury is to be prevented. A thorough spraying with kerosene emulsion at a strength of 1 part of the stock solution to 5 parts of water would destroy most of the insects that it hit, and by using a drag in front of the nozzles to turn the leaves and cause the insects to jump, most of them could be reached. Where the insects were coming in in numbers this spray would need to be followed by a second one ten days later.

Several mechanical devices have been used to catch different leafhoppers, and no doubt several of these could be used against this insect with advantage. The tar pan, or "hopper-dozer," drawn over the beets two or three times in the first few weeks would capture a large number of them. The females, before the eggs are laid, are quite heavy and do not jump or fly as readily as the males and would be easily caught. A modified form of the machine, consisting of a couple of tarred wings to be drawn along on each side of a row of beets, while a drag agitated the tops and caused the insect to fly, would probably capture more than the simpler tar pan.

If the insects appeared while the beets were quite small, they could be largely destroyed by rolling when the weather was cold or damp and the insects sluggish.

A number of preventive measures may be used to assist the beets in withstanding the attack of the leafhoppers. In some sections early planting will produce beets large enough to shade the ground by the time the beet leafhoppers appear, and thus reduce the temperature below the danger line. In a few places, like the Grand Junction district in Colorado and Sevier County in Utah, early planting alone would not avail, as the insects appear soon after the earliest beets come through the ground. For such sections early and frequent irrigations would assist in keeping the ground cool until the beets grew large enough to shade it and thus take care of themselves.

All preventive measures will depend for success upon some method of controlling the temperature in the field so that the ground may not be hot and dry at the time the leafhoppers appear.

Undoubtedly some of the remedies advised against the hop flea-beetle, an entirely different insect and one which also affects sugar beets, in Bulletin 66, Part VI, of the Bureau of Entomology, pages 83-91, and in a supplementary article, Bulletin 82, Part III, on the same species, will be found useful. Particular attention is called to the latter publication by Mr. W. B. Parker, collaborator of the Bureau of Entomology, as the experiments have been very carefully carried out with the hop flea-beetle, which from its habit of flying quickly and hopping resembles leafhoppers, in that the beetles can be reached in somewhat the same way.

